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PRESERVATION AND PURIFICATION OF DRY RINDERPEST VACCINE

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In their reports on dry rinderpest vaccine Robles and Generoso^(3,4) observed that vaccine in the flake or unpulverized form exposed to room temperature (20° to 30°C.) for 6 days is not affected in its potency, but subjected to exposure under the same conditions for 32 days shows a definite loss of protective value. In the powdered state its potency was retained for 91 days in the ice box (0.8°C.), but tests showed loss of potency due to exposure to room temperature under shipping conditions. A marked deterioration was noted in 36 months at ice-box temperature, and in 29 days under mailing conditions (atmospheric temperature).

Jacotot⁽²⁾ in the third part of his report mentions two experiments on vaccine prepared by dehydration of the virulent spleenic pulp. In one experiment he found that from the 2d to the 6th month at ordinary temperature (exact temperature not given) the protective dose of the vaccine tested varied from 0.5 or 0.75 gram to 0.75 or 1 gram. In the second experiment he found that the antigen which 2 months after preparation was active in a dose of 0.75 gram was effective after 6 months only when the dose was doubled to 1.5 grams. No literature is available on the factor or factors responsible for such deterioration; however, it is a common observation that when fresh meat is exposed to room temperature, the fat turns rancid. This process is known as fat oxidation, and leads readily to the final spoilage or decomposition. Quite successfully

Birdseye(1) and others have prevented spoilage by quick, slow, or "sharp" freezing. Birdseye was particularly successful with sharp freezing in the packing of fresh meats and fish for delivery. Since the dry rinderpest vaccine is per se a tissue derivative, the observations of Birdseye may conceivably explain its deterioration, so that its keeping quality may be enhanced by extraction of its fat content. The following experiments were conducted to investigate these possibilities.

MATERIALS AND METHODS

Materials.—The material for these experiments consisted of 11 serials of regular dried rinderpest vaccine: D-14, D-16, D-18, D-19, D-20, D-21, D-26, D-27, D-28, D-31, and D-32. Sample bottles containing 10 grams of vaccine each were obtained after the preparation of each batch. As each sample was treated differently it will be described separately. Squibb ether for anaesthesia was used as the extracting agent. Acetone, 95 per cent and absolute alcohol, and formalin were also tried.

Methods of fat extraction.—The methods of extraction used were:

1. Shaking the vaccine once, twice, or three times with Squibb ether in a bottle at room temperature (20° to $30^{\circ}\text{C}.$) 1 ounce of ether to every 10 grams of dry vaccine. Then the ether was decanted and the residue allowed to dry on an ordinary filter at room temperature.

2. Shaking with ether, acetone, and alcohol, respectively, one after the other. The residue was dried at $37.5^{\circ}\text{C}.$

3. Continuous extraction with ether in a Soxhlet extraction apparatus for 4 to 5 hours or until the ether extract remained colorless at $40^{\circ}\text{C}.$ Upon reaching the vaccine in the thimble the temperature falls to about room temperature. Quantitative determination of the fat content of the dry vaccine by one of us by this method gave from 10 to 18.65 per cent.

Testing for potency.—Every batch of vaccine that had gone through extraction was put in amber-colored bottles and kept at room temperature. Its potency was then tested on susceptible cattle and carabaos. Some batches were tested immediately after the treatment, others sometime thereafter. A few had more than one test at varying intervals. The majority, however, had but one test several months after extraction. The vaccine was injected intramuscularly on the back muscle behind the scapula at the dosage indicated. Two weeks after, 1 to 2 cc of virulent rinderpest virus (citrated blood) was injected into the

test animals, including one control. All controls developed rinderpest and were killed for vaccine. The test animals which developed clinical rinderpest after virus inoculations were killed for vaccine and were designated as "clinical rinderpest." Those that showed only thermic reaction were designated as having had "temperature reaction" while those that had no signs of disease were designated as having had "no reaction."

DESCRIPTION OF VACCINES; THEIR TREATMENT AND POTENCY TESTS

Serial D-14.—The vaccine was 2 years and 28 days in the ice chest and was still potent at a 0.5 to 1 gram dosage for cattle and carabaos, respectively. A sample of this vaccine was treated with ether once at room temperature and kept at the same temperature for 1½ years. Two grams of the dried vaccine protected carabao No. 1368 against virulent blood.

Serial D-16.—Serial D-16 was a freshly ground vaccine, potent in carabaos at a 1.5 gram dosage. Two lots were prepared. Lot 1 was treated with ether three times in 1½ hours, or 30 minutes each time. Lot 2 was treated with ether twice, 15 minutes each time, once for 10 minutes in acetone, 48 hours in 95 per cent alcohol, overnight with absolute alcohol, and then dried on filter paper at 37.0° C. Dalupiri carabaos 1318 and 1315 received 1 gram of each vaccine, respectively. Given the virus two weeks later the first animal showed a temperature reaction only, while the other developed clinical rinderpest and was killed for vaccine.

Serial D-18.—The untreated vaccine protected a carabao which developed a temperature reaction after virus inoculation. A bottle of this vaccine was treated three times with ether at room temperature during night time. It was filtered through paper and dried at room temperature. Twenty-four hours after treatment 1 gram of the vaccine was injected into Dalupiri carabao 1327. Fuga cattle 3094 and 3053 each received 0.5 gram of treated vaccine 3 months old. Tayabas bull 2423 received 0.5 gram of vaccine 5 months old. Fuga bull 3406 received 0.5 gram of vaccine 1 year 6 days old. No reaction followed the test dose of virulent blood in all these animals, except the last which showed a temperature reaction of a few days.

Serial D-19.—In the regular potency test 1.5 grams of this vaccine 20 days after preparation did not protect a carabao. A bottle of it was treated with ether three times and its potency tested on Dalupiri carabao 1320 at 1 gram dosage. The animal developed only a temperature reaction.

Serial D-20.—The untreated vaccine was potent at 0.5 gram and 1 gram doses in cattle and carabaos, respectively, but after 5 months and 24 days 0.5 gram was no longer protective to cattle. A bottle of this vaccine, 3 weeks old, was treated with ether 3 times, and Dalupiri carabao 1342 and Fuga bull 2950 were inoculated with the vaccine 24 hours after the latter was treated with ether at 0.6 and 0.3 gram doses, respectively. The first animal showed clinical rinderpest, while the other showed no reaction. Fuga bull 3258 was injected with 0.5 gram of vaccine 5 months old, with no reaction. Dalupiri carabao 1375 received 1.32 grams of vaccine 7 months and 19 days old. The animal developed clinical rinderpest upon virus inoculation but recovered completely. Fuga bull 3537 received 0.5 gram of vaccine 1 year and 1 month old. The animal showed a marked temperature reaction upon injection of virulent blood. One gram of the vaccine of this serial with the fat newly extracted was wrapped in sterile filter paper and exposed to formaldehyde gas in a desiccating chamber for 30 minutes, the formalin extracted by vacuum, and the vaccine allowed to stand overnight for further evaporation of the gas. The vaccine was found sterile in cultural tests. A potency test was made on Fuga bull 2942 at a 0.5 gram dosage, but when the virus was given, the animal developed clinical rinderpest and was killed for vaccine.

Serial D-21.—Originally this was a rather weak vaccine which did not protect a carabao at a 1 gram dosage. A bottle of this vaccine was treated with ether three times at room temperature for 1 hour, then dried in the incubator at 37°C. for 30 minutes. Its potency was tested on Dalupiri carabao 1336 at 1 gram, but upon inoculation of virulent blood the animal developed rinderpest and was killed for vaccine.

Serial D-26.—A potency test of the regular vaccine freshly prepared resulted in a temperature reaction in cattle and clinical rinderpest in carabaos after virus inoculation. A bottle of this vaccine was treated with ether twice, dried at room temperature, and its potency tested 7 months later. For comparison the original vaccine of the same batch kept in the frigidaire was also tested. Mindoro bull 3516 received 0.5 gram of the original vaccine, and Mindoro bull 3510 the same dose of the purified vaccine 7 months old. When virulent blood was given to both animals the first developed clinical rinderpest and the second showed no reaction, showing the superiority of the purified material.

Serial D-27.—The regular vaccine tested immediately after preparation was potent at 0.5 gram for cattle, but not for

carabaos at 1.5 grams. Four days after preparation a bottle of this vaccine was treated with ether three times, dried, and kept at room temperature; 8 months later it was protective to Fuga bull 3584.

Serial D-28.—The untreated vaccine was potent for cattle at 0.5 gram and for carabaos at 2 grams soon after preparation. From a bottle of this vaccine 8 days old the fat was extracted with ether in a thimble for 5 hours at 40°C., and the vaccine dried in the incubator at 37°C. for a few hours. Seven and a half months after treatment its potency was tested on Fuga bull 3583, which developed a temperature reaction after virus inoculation.

Serial D-31.—This vaccine freshly prepared protected cattle at 0.5 gram but not carabaos at 2 grams. From a sample the fat was extracted with ether in a thimble for 3 hours at 40°C., and the vaccine dried for 24 hours in the incubator at 37°C. Six and one-half months later its potency was tested at 0.5 gram on Fuga bull 3582 which showed a temperature reaction after receiving the virus.

Serial D-32.—The regular vaccine soon after preparation was potent at 2 grams for carabaos and at 0.5 gram for cattle. A sample was treated with ether for 6 hours in a thimble and the vaccine dried 24 hours at room temperature. Its potency was tested on Fuga bull 3566. There was a slight temperature reaction to virus inoculation.

The details of the tests on the 11 serials of dry vaccine are summarized in Table 1.

DISCUSSION

The results of the foregoing experiments seem to show that fat extraction with Squibb ether is a promising method of preserving and purifying dry vaccine. By treating a vaccine that was originally potent with ether one to three times for 30 minutes each at room temperature, a considerable amount of fat was removed, and the process did not seem to destroy the antigenic property of the vaccine. This is shown particularly by the potency tests of D-14, D-18, D-26, and D-27. On the other hand, treating a potent vaccine with ether in any other way, such as lengthening the time of exposure, or extraction or dehydration at higher temperatures, tends to lower potency, as shown by the tests on serials D-21, D-28, D-31, and D-32. However, D-21 was not a potent vaccine to start with. Likewise, a potent ether-treated vaccine subjected to other chemical treatment lost

TABLE 1.—Potency of dry vaccine after extraction of fat and storage at room temperature.

Serial number.	Agent.	Extraction.			Interval between extraction and test...	Test number.	Animal.	Dosage.	Remarks.	
		Time.	Duration.	Drying temperature.						
D-14--	Ether	1	30 min.	Room	11 years	1	Carabao 1368	cc. 2.0	No reaction.	
	[Ether]	3	30 min.	Room	1 day	1	Bull 344 (Control)	--	Killed for vaccine.	
	Ether	2	15 min.			1	Carabao 1318	1.0	Temperature reaction (recovered).	
	Acetone	1	10 min.			1	Bull 2986 (Control)	--	Killed for vaccine.	
D-16--	Alcohol (9%)	1	48 hrs.	37°C	do	1	Carabao 1315	1.0	Clinical rinderpest, killed for vaccine.	
	[Alcohol (100%)]	1	overnight			1	Carabao 1327	1.0	No reaction.	
	Ether	3	15 min. or less	Room	1 day	2	Bull 3094	0.5	Do.	
					3 mos.	2	Bull 3053	0.5	Do.	
D-18--	Ether	3	15 min. or less	Room	5 mos.	3	Bull 3067 (Control)	--	Killed for vaccine.	
						3	Bull 2423	0.5	No reaction.	
					1 yr. 6 days	4	Bull 3188 (Control)	--	Killed for vaccine.	
						4	Bull 3406	0.5	Temperature reaction.	
D-19--	Ether	3	30 min.		do	20 days	1	Bull 3546 (Control)	--	Killed for vaccine.
						1 day	1	Carabao 1320	1.0	Temperature reaction.
								Bull 2978 (Control)	--	Do.
								Bull 2950	0.3	No reaction.
								Carabao 1342	0.6	Clinical rinderpest, killed for vaccine.

Ether.....	3	15 min. or less.	Room.....	5 mos. 24 days.....	Bull 2969 (Control).....	2	Killed for vaccine.		
				No reaction.	Bull 3258.....	2	No reaction.		
D-20.....					Bull 3602 (Control).....	2	Killed for vaccine.		
					Carabao 1376.....	1	Clinical rinderpest (recovered).		
				7 mos. 19 days.....	Bull 3408 (Control).....	2	Killed for vaccine.		
				1 yr. 1 mo.....	Bull 3387.....	2	Maintained temperature reaction.		
Formaldehyde.....	1	30 min.....	Room.....	16 days.....	Bull 3547 (Control).....	2	Killed for vaccine.		
					Bull 2942.....	0.5	Clinical rinderpest, killed for vaccine.		
Ether.....	3	1 hr.....	37°C.....	None.....	Bull 3022 (Control).....	2	Killed for vaccine.		
D-21.....					Carabao 1386.....	1.0	Clinical rinderpest, killed for vaccine.		
					Bull 2940 (Control).....	2	Killed for vaccine.		
				7 mos.....	Bull 3516.....	0.5	Clinical rinderpest, killed for vaccine.		
Ether.....	2	15 min. or less.	Room.....	-do-	Bull 3510.....	0.5	No reaction.		
D-26.....	3	-do-	Room.....	8 mos.....	Bull 3531 (Control).....	1	Killed for vaccine.		
D-27.....					Bull 3584.....	0.5	No reaction.		
D-28.....	1	5 hrs. b.....	37°C.....	7½ mos.....	Bull 3499 (Control).....	1	Killed for vaccine.		
					Bull 3583.....	0.5	Temperature reaction.		
D-31.....	1	3 hrs. b.....	1 day at 37°C.....	6½ mos.....	Bull 3499 (Control).....	1	Killed for vaccine.		
D-32.....	1	6 hrs.....	1 day at room temperature.	8 mos.....	Bull 3566.....	0.5	Temperature reaction (6th day).		

* Untreated vaccine kept in a fridgidaire.

At 40° C.

its potency completely, as is shown by the results of the potency test of lot 2, D-16, which was subjected to the action of acetone and two strengths of alcohol (95 and 100 per cent) successively. A portion of the ether-treated vaccine potent on cattle in 0.3 gram dosage exposed to formaldehyde gas for 30 minutes also lost its potency, even at 0.5 gram. While the gas sterilized the vaccine it also destroyed its potency.

In one instance it was noted that treating a vaccine of low-original titer with ether apparently improved its protective value, as in the test of D-19, in which the test carabao had only a temperature reaction at 1 gram dosage, while in the virus test the untreated vaccine failed to protect even at 1.5 grams. Taking the maximum amount of fat extracted to be 18 per cent, the test animal in the former case still received less vaccine than the latter.

Generally speaking, however, if one starts with a vaccine of low potency, no further treatment can improve its preserving quality, potency, and concentration, as shown in the case of D-21, in which the test animals injected with untreated and treated material did not resist the virus inoculation and had to be killed for vaccine.

Serials D-14 and D-20 are extraordinarily good vaccine as shown by the fact that $3\frac{1}{2}$ years after preparation they protected the test carabao at 2 grams against the test dose of virulent blood. (Two years and 28 days in the ice chest in the untreated form and $1\frac{1}{2}$ years at room temperature after fat extraction). Similarly, the first potency test of D-20 protected a susceptible bull at a reduced dose of 0.3 gram, although it failed to protect a carabao at twice that dose, 0.6 gram. This vaccine remained potent up to 5 months and 24 days at room temperature. After 7 months, however, its potency began to decline.

Serials D-14, D-26, and D-27 are the best examples of the ether-treated vaccine the keeping quality of which has been enhanced 7 to 18 times over that of ordinary untreated vaccine, under the same condition as shown by the results of the potency tests.

The fact that all of the ether-treated vaccines were kept at room temperature, and that the results of their potency tests compared favorably with those of the vaccine kept in the ice box, indicates a high degree of preservation and purification. Since ordinary dry vaccine kept only 30 days at most at room

temperature, the foregoing experiments show that its keeping quality at room temperature was improved considerably by fat extraction. These experiments, moreover, show that a potent vaccine subjected to the ether treatment at ice-box temperature and stored in the refrigerator would probably maintain its potency over much longer periods than those recorded herein.

Topacio and Robles⁽⁵⁾ in a previous paper tentatively concluded that dry vaccine does not owe its antigenic value to the presence of living virus. The various lethal operations to which the dry vaccines used in the present experiments were subjected would seem to bear out that view.

SUMMARY AND CONCLUSIONS

1. An attempt to preserve and purify the dry rinderpest vaccine by fat extraction with Squibb ether has been described.
2. The best results were obtained by treating the vaccine with ether 1 to 3 times for 30 minutes each by simple decantation at room temperature, followed by drying at the same temperature (20° to 30°C.). By this method of extraction the potency of the vaccines was not impaired, and their keeping quality was preserved for from 3 months to 1½ years at room temperature.
3. Overtreatment or treatment at higher temperatures apparently had a deteriorating effect on the antigen.
4. Extraction with alcohol and acetone or exposure to formalin destroyed the potency of the vaccine, presumably due on the one hand to the complete removal of the antigenic lipo-proteins by the solvents, and to the destructive effect of formalin on the other.
5. Apparently the keeping quality at room temperature of a potent vaccine treated with Squibb ether by simple shaking and decantation was enhanced 7 to 18 times over that of the untreated material in the case of Serials D-14, D-26, and D-27. (Table 1).
6. The results of the foregoing experiments, in which no vaccine showed any detectable signs of living virus as shown by its reaction on the test animals, confirms the previous observation of Topacio and Robles that virulence is not involved in the immunizing property of the product.
7. There is evidence that extraction in the refrigerator would further improve the purity and keeping qualities of the product over the results already obtained.

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ELECTROLYSIS OF METHYL MAGNESIUM IODIDE IN PYRIDINE SOLUTION¹

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The electrolysis of the Grignard reagent has been carried out in ether solution by a number of workers.(3-9) Overcash and Mathers(10) studied the electrolysis of various organic magnesium complexes dissolved in organic solvents. Pyridine was unsatisfactory as a solvent for the deposition of magnesium, and dimethyl aniline gave the best results.

The mechanism of electrolysis in ether solution has been shown by Evans and co-workers(3, 4) to give magnesium plating out at the cathode, and magnesium halide, gas, and oil at the anode.

Pyridine, a tertiary base in which the Grignard reagent may be prepared, is much less volatile than ether, and has a greater dielectric constant that makes it suitable for electrodepositions. The use of this solvent for the electrolysis of alkyl magnesium halides would test the generality of the mechanism of the reactions in ether solutions.

EXPERIMENTAL

Preparation of pyridine.—Chemically pure pyridine was dried over potassium hydroxide for two weeks, distilled from barium oxide, and kept over barium oxide until used, when it was again distilled.

Preparation of Grignard reagents.—Methyl magnesium iodide was prepared in ether solution, filtered, analyzed, and an aliquot used. A small amount of pyridine was added to precipitate the addition compound, and the ether removed by vacuum evaporation. The compound prepared in this way was perfectly white, whereas other methods involving filtering in air gave yellow precipitates. The addition compound was dissolved in addi-

¹ Manuscript received August 5, 1937.

tional pyridine for electrolysis. The pyridine solution prepared in this way was water white, whereas the preparation of the Grignard directly in pyridine solution gave a red solution and a precipitate of dark tar. The pyridine addition compound of methyl magnesium iodide had a solubility of about one gram per 100 cc of pyridine at room temperatures. Heating increased the solubility but caused the solution to darken.

Electrolysis of the solution.—The ether solution of the Grignard reagent was electrolysed with essentially the same results obtained by previous workers.

Electrolysis of the Grignard compound in pyridine was carried out in a graduated cylinder 6 cm in diameter and 14 cm high. Electrodes were platinum, 1.5 x 2.5 cm; potential across electrodes was 124 volts. When it was electrolysed, the solution darkened in color, no magnesium was deposited, gas bubbles were liberated at the cathode, and a gummy substance deposited on the surface of the cathode, which reduced the flow of current from initial 0.03 ampère to 0.008 ampère after 30 minutes. Various attempts were made to eliminate the deposit on the cathode. Agitation of the solution minimized but did not prevent the formation.

A divided cell was then used in which the anode was placed in an alundum thimble containing pure pyridine; the cathode was a rotating platinum spiral placed in the pyridine solution of the Grignard compound. Iodine was liberated at the anode. A number of runs were made on 100 cc of solution containing 1 gram of the pyridine addition compound of methyl magnesium iodide. Current flow fell from 0.1 ampère to 0.003 ampère after 45 minutes, when the cathode was cleaned and the electrolysis continued. The weight of deposit on the cathode was determined and the iodine in the anolyte titrated with thiosulfate. Typical results are given in Table 1.

TABLE 1.—*Results of the electrolysis of the Grignard compound in pyridine.*

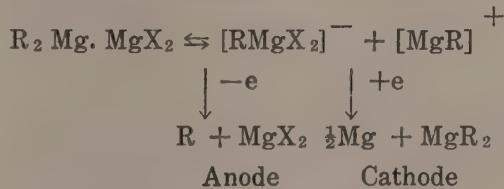
Run.	Coulombs.	Cathode deposit. g.	Iodine at anode. g.	Anode eff. Per cent.
A 1	13.0	0.0053		
A 2	10.4	0.0082		
A 3	14.0	0.0088		
A 4	15.8	0.0085		
Total	52.7	0.0308		
B	38.9	0.0157	0.048	84.3
C	22.7	0.0108	0.024	82.8

Nature of the product.—The cathode deposit formed in the first experiments was a sticky brown mass. In the divided cell it formed as a brown powder with characteristic odor, soluble in water and decomposed by hydrochloric acid. It was analysed qualitatively for magnesium by the p-nitrobenzene azoresorcinol test, and magnesium found to be present. To determine whether the Grignard or pyridine was responsible for the deposit, a solution of anhydrous magnesium chloride in pyridine was electrolysed under the same conditions. The deposit was formed in the same way and gave a quantitative test for magnesium, indicating that the pyridine is responsible for the deposit.

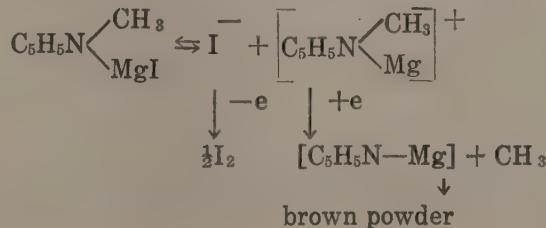
The gas liberated at the cathode was too small in quantity to be collected and analysed.

DISCUSSION OF RESULTS

The addition compounds of the Grignard reagent with pyridine are supposed to have the structure of a substituted ammonium salt. Bergstrom and McAllister⁽²⁾ by their preparation of 2-alkyl and 2-aryl pyridines have shown that this addition compound is stable up to high temperatures, at which rearrangement occurs. The mechanism of the electrolysis of methyl magnesium iodide in pyridine may be compared with ether solutions. In ether Evans and Field⁽³⁾ postulate



In pyridine solution the reaction may be represented by



It is interesting to note that a concentration of 0.1 to 1.5 mols per liter of Grignard reagent in ether would conduct but 0.2 to 0.4 ampère; the pyridine solution containing less than 0.1 mol per liter gave an initial current of 0.06 to 0.1 ampère, which decreased as the cathode deposit formed.

TABLE 2.—*Results of electrolyzing methyl magnesium iodide in pyridine solution compared with electrolysis in ether solution.*

Electrode.	Solution.	
	Ether.	Pyridine.
Anode.....	Gas liberated.....	Iodine liberated.
Cathode.....	Magnesium plated out.....	Gas liberated and brown deposit formed.

SUMMARY

The electrolysis of methyl magnesium iodide in pyridine solution has been investigated. The results are compared with those for electrolysis in ether solution.

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A NOTE ON MOSELEY'S LAW

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In view of the simple interrelationships between the physical properties of compound, such as heat of formation, electrolytic decomposition potential,(1) solubility, compressibility, melting point, and others,(2) and the simple method of calculating the value of the electronic charge, e ,(3) as given in previous works, it was thought that possibly the atom has a structure much simpler than any of those attributed to it.

Consider a wave emanating from an electron of an atom whose radius is r . Planck found that a definite amount of energy, h , goes with each wave. It is evident that the energy per unit area on the wave front at a distance r from the center of the atom is distributed over $4\pi r^2$. Likewise a wave front at a distance mr from the center will have an energy per unit area distributed over $4\pi (mr)^2$, hence if E_1 and E_m are the intensities of energy on the two wave fronts the difference in intensities is

$$E_1 - E_m = \frac{h}{4\pi r^2} \left(\frac{1}{1^2} - \frac{1}{m^2} \right) \quad (1)$$

Represent now by $\Delta E'$ the energy emitted per second from every unit area of the atomic surface; if this energy is proportional to the difference in intensities, $E_1 - E_m$, then, introducing a proportionality constant, B , we obtain the equation

$$\Delta E' = B(E_1 - E_m) = \frac{hB}{4\pi r^2} \left(\frac{1}{1^2} - \frac{1}{m^2} \right) \quad (2)$$

Multiplying by $4\pi r^2$ to get the energy emitted through the whole atomic surface, we get the relation

$$\Delta E' 4\pi r^2 = hB \left(\frac{1}{1^2} - \frac{1}{m^2} \right) \quad (3)$$

If now we call the energy emitted by the atom in one second ΔE , it is evident that

$$\Delta E = hB \left(\frac{1}{1^2} - \frac{1}{m^2} \right) \quad (4)$$

where B is the proportionality constant, its value depending upon the units of the other factors. If ΔE is the energy per second, by the definition of h given above

$$\Delta E = h\nu \quad (5)$$

where ν is the frequency or number of waves per second. Putting now (5) in (4),

$$h\nu = hB \left(\frac{1}{1^2} - \frac{1}{m^2} \right) \quad (6)$$

On the right the only variable is m , and as m approaches infinity, $\frac{1}{m^2} = 0$, and

$$\nu = B \quad (7)$$

That is, the frequency is B if the value of the second term in the bracket becomes 1. We can identify B in equation (6) as Rydberg's fundamental frequency in the well-known Balmer's equation. The frequency of B then is the proportionality constant between the energy of the atom and the difference in intensity of energy between the first and $(\nu + 1)$ th waves.

Consider now that in the atom there are n electrons that can emit waves. If $\frac{r}{n}$ is used instead of r in equation (1), equation (4) takes the form

$$\Delta E = Bhn^2 \left(\frac{1}{1^2} - \frac{1}{m^2} \right) \quad (8)$$

and equation (7)

$$\nu = Bn^2 \quad (9)$$

Equation (9) is the equation for Moseley's law.

Whatever the true picture of the electrons might be at the time of the emission of waves, it seems that the foregoing considerations lead to the following attributes of the electrons when they act as centers of waves:

1. The electrons comprise the greater bulk of the atoms.
2. The n electrons of an atom are arranged as concentric shells with their centers coinciding with the center of the atom.
3. The thickness of the shells is the same or nearly so at the time of wave emission, its value being $\frac{r}{n}$, where r is the radius of the atom at the moment and n the atomic number.

4. If the waves emanate from the innermost shell, the energy quantum is distributed over its surface, so

that one unit area emits energy equal to $\frac{h}{4\pi \left(\frac{r}{n}\right)^2}$;

if from the second it is $\frac{h}{4\pi \left(\frac{2r}{n}\right)^2}$, from the third,

$\frac{h}{4\pi \left(\frac{3r}{n}\right)^2}$ and so on.

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NEW LONGICORN BEETLES FROM FORMOSA, IV
(COLEOPTERA: CERAMBYCIDÆ)

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ONE PLATE AND ONE TEXT FIGURE

This continuation of the present series, largely based on material collected by myself in Formosa in 1932 and 1934, forms my eighth contribution to the knowledge of the longicorn beetles of Formosa.¹ The localities at which the specimens were collected have also been described in a previous paper.² Herein are described fifteen new species or subspecies of the subfamilies Prioninæ, Cerambycinæ, and Lamiinæ. Several of the forms newly named were previously recorded from the island as continental species, but direct comparison with typical examples has proven them distinct. Besides the descriptions, some generic corrections and synonymies are presented. I am greatly indebted to Dr. K. G. Blair, of the British Museum, for kindly making comparisons and for making available to me certain material. The type specimens of the new forms are deposited in the United States National Museum in Washington, D. C., or are placed on loan deposit by myself in the type collection of the California Academy of Sciences in San Francisco.

PRIONINÆ

MACROTOMINI

Genus MACROTOMA Serville, 1832

MACROTOMA FISHERI subsp. FORMOSÆ Gressitt subsp. nov.

Macrotoma fisheri LAMEERE, Arch. Naturgesch. 79 (1913) 175; Cat. Coleopterorum 52 (1913) 29 (part); KANO, Trans. Nat. Hist. Soc.

¹ Previous papers on longicorns were published in Pan-Pacific Entomol. 9 (1933[4]) 163–170. Philip. Journ. Sci. 55 (1934[5]) 379–386; 57 (1935) 181–194; 58 (1935) 253–266; 61 (1936) 89–111, pl. 1. Insecta Matsumurana 9 (1935) 144–153. Trans. Nat. Hist. Soc. Formosa 25 (1935) 286–292.

² Notes on collecting in Formosa. Entomological World (Tokyo) 4 (1936) 711–727, 6 figs., 1 map.

Formosa 16 (1926) 120; MIWA, Gov. Res. Inst. Formosa, Dept. Agr. Rep. 55 (1931) 195; YOSHIDA, Trans. Nat. Hist. Soc. Formosa 21 (1931) 268; MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 162 (nec C. O. Waterhouse, 1884).

Male.—Very large, subparallel. Light reddish brown; first three antennal segments blackish; head and forelegs dull reddish to black; middle and hind legs deep red to reddish black. Dorsal surface glabrous except for tawny yellow hairs on clypeus, labrum, mandibles, mesothorax, and anterior and posterior margins of prothorax; thoracic sterna similarly clothed; abdomen glabrous except for lateral margins, apex of last, and a single row of hairs on fourth, segment.

Head, including mandibles, nearly twice as broad as long, deeply impressed on frons, narrowly and deeply concave between swollen antennal insertions, smooth and shallowly concave between the subapproximate superior eye lobes, finely sulcate medially for length of occiput, granulose-punctate behind eyes; mandibles coarsely punctured, strongly toothed before apices. Antennæ reaching to apical quarter of elytra; first three segments nearly three times as wide as following; scape rectangular and slightly concave when viewed from front, more than twice as long as broad, fairly coarsely punctured; third segment twice as long as scape and nearly as long as fourth to sixth segments united, slightly arched, concave, and broadly, though sparsely, punctured above, asperate beneath; seventh to ninth segments subreticulate above. Prothorax twice as broad as long, gradually narrowed anteriorly; lateral margins with a number of short fine teeth, some long, obliquely pointing teeth at posterior angles; disc coarsely and densely punctured, except for smooth, shiny middle and base. Scutellum practically impunctate. Elytra very slightly broader behind middle than at base, very finely vermiculate-rugulose, shiny near base, bearing four weakly raised costæ; apices broadly rounded and very weakly toothed at sutural angles. Metepisternum microscopically and closely punctulate. Abdomen practically impunctate, except for last segment. Forelegs sparsely asperate-punctate, strongly spined internally, the femora transversely grooved below; middle and hind legs glossy, nearly impunctate externally and internally, finely toothed below; first hind tarsal segment practically as long as following two segments combined, last segment nearly as long as first three together.

Female.—Antennæ finer, reaching to middle of elytra; scape twice as long as broad; third segment flat above; last two lon-

gitudinally multicarinate. Forelegs smaller, no more tuberculate than middle and hind legs.

Length, 45 to 69 millimeters; breadth, 17 to 23.

Holotype, male (No. 52191, United States National Museum), Hori (Horisha), central Formosa, altitude 550 meters, June 1935; allotopotype, female, July, 1932, author's collection; four paratotypes, three males and one female, July, 1932, June 1934, and June and July 1935, two in the author's collection and one in Lingnan Natural History Survey Museum, Canton; two paratypes, Rokki (Rokkiri), southwestern Formosa, June 16, 1932, one in van Dyke collection, California Academy of Sciences, the other in the author's collection, taken by the author.

Differs from *M. fisheri* Waterhouse,³ of Burma, in having the third antennal segment longer, the elytra smoother, the scutellum and abdomen impunctate, the middle and hind legs less punctate, and the elytra darker and more uniformly colored.

MACROTOMA KATOI Gressitt sp. nov. Text fig. 1.

Male.—Moderately large; length slightly more than three times breadth at shoulders, moderately dark brown; paler on elytra, with a reddish brown tinge, except for basal portions and apices; middle and hind legs and abdomen more reddish and somewhat shiny; head nearly black; first three segments of antennæ dark brown, remaining segments reddish brown and slightly shiny, like legs. Devoid of hairs except for moderately short and sparse golden-buff pubescence on labrum and anterior dorsal and ventral, and posterior dorsal, margins of prothorax; dirty golden pubescence on ventral surfaces of tarsi and at apex of last abdominal segment.

Mandibles medium-sized, black, slightly curved, basal two-thirds rough and punctate, apices smooth, pointed, with two small projecting teeth on cutting edge one-third length from apex; labrum and palpi light reddish brown; epicranial suture shallow on top of head, deeper on frons, branching at margin of



FIG. 1. *Macrotoma katoi*
Gressitt sp. nov.

³ Ann. & Mag. Nat. Hist. (5) 14 (1884) 382 (Burma).

frons and clypeus, forming a deep but short transverse groove; antennal supports very slightly projecting; neck short, nearly as wide as width of head across eyes; occiput slightly punctate, genae rough. Antennæ not quite as long as body; scape rectangular when viewed from front, its sides subparallel; second segment short and ring-shaped; third stout, rough, but without true spines, three times as long as scape; fourth to last segments narrowed and subequal in length, smooth. Pronotum armed with short spines at lateral margins, moderately smooth, with four large, and two small, raised, and sparsely punctured glossy areas arranged in the form of a transverse rectangle on disc. Elytra broadest in middle, moderately smooth except at base, veins slightly raised. Forelegs rough, short spines on inner sides; middle and hind legs moderately smooth.

Length, 46 millimeters; breadth, 16.5.

Holotype, male, M. Kato collection, Tokyo; Tainan, southwestern Formosa, altitude 25 meters, May, 1922, collected by Mr. Masayo Kato, who kindly loaned the specimen to me for study and executed the accompanying brush drawing, and for whom the species is respectfully named.

This species differs from *M. crenata* (Fabricius), of India, in being shorter, in having the scape more than one-third longer than broad, the prothorax broader, the pronotum with a much wider basal callosity connected with a pair of anterior swollen shiny areas, the sides of the prothorax more rounded and bearing more numerous and finer spines, the femora a little less rough, and in other features. The illustration has the antennæ slightly exaggerated in length in comparison to the body. This species is probably the same as the form recorded from Formosa as *M. crenata* (Fabricius) by Yoshida and Matsushita.

CERAMBYCINÆ

MOLORCHINI

Genus EPANIA Pascoe, 1857

EPANIA SUBGLABRA Gressitt sp. nov. Plate 1, fig. 7.

Female.—Elongate, subparallel, robust; shiny black, apices of tarsi and bases of femora somewhat reddish brown, middle and hind tibiæ very slightly reddish, hind wings with steel-blue reflections; sides of anterior and posterior edges of swollen portions of prothorax finely clothed with silvery pubescence which is visible only at certain angles; scutellum, mesepimera, apices of me-

tepiستerna and metepimera, margins of hind coxae, middle of lateral margin of first abdominal segment, and bases of lateral portions of second to fourth abdominal segments, clothed with silvery pubescence. Body largely clothed with fine erect pale hairs; elytra nearly glabrous; antennae with a few short erect hairs on outer sides of first three segments and a few on inner sides of following three segments; fifth and following segments clothed with thin dull pubescence.

Head very short, plane in front, moderately coarsely punctured; frons fully as wide as high; vertex weakly concave; inferior lobes of eyes very large, rounded. Antennae moderately thick, two-thirds as long as body; scape barely longer than third and fourth segments, slightly shorter than fifth, following diminishing in length. Prothorax longer than broad, strongly constricted basally, weakly so before apex; swollen portion coarsely reticulate-punctate. Scutellum as broad as long, concave, rounded apically. Elytra each nearly twice as long as broad, reaching to apices of metepisterna, obliquely truncated internally and rounded at apices; humeri strongly produced anteriorly; surface of each very sparsely and shallowly punctured; an arcuate depression extending from inside of humerus to truncate margin, closer to suture than to apex. Hind thorax finely and closely punctured; abdomen finely and sparsely punctured; first abdominal segment one-half again as long as second. Femora arcuate-pedunculate and abruptly clavate, hind pair reaching beyond fourth abdominal segment and clavate for slightly less than one-half their lengths; hind tibiae nearly straight, weakly rugose; hind tarsi very slender, first segment slightly longer than following two together, shorter than last.

Length, 12 millimeters; breadth, 3.

Differs from *E. brevipennis* Pascoe in being larger, in having the antennae black instead of brown, the elytra black instead of blue and more weakly punctured, the scutellum with silvery, instead of yellowish, pubescence, hind legs black instead of blue, ventral surface black instead of brown, and in other features. Differs from *E. subchalybeata* Miwa in having the bases of middle and hind femora dark instead of testaceous, the head and prothorax black instead of blue, and in other respects. Differs from *E. shikokensis* Ohbayashi in being longer, with the prothorax less closely punctured, the elytra longer and less distinctly punctured, the middle and hind femora dark basally and less clavate, the ventral surface less shiny, the hind tibiae less rough and sinuous, and the hind tarsi slenderer.

Key to the Formosan species of Epania.

1. Scape shiny black 2.
Scape reddish or brown 3.
2. Elytra obliquely truncate; first four antennal segments shiny; hind femora clavate for less than one-half their length; legs entirely black.
subglabra Gressitt.
Elytra broadly rounded behind; first three antennal segments shiny; middle and hind femora testaceous basally; hind femora clavate for fully one-half their length *shikokensis* Ohbayashi.
3. Hind femora entirely chalybeate blue; head and prothorax black.
brevipennis Pascoe.
Middle and hind femora yellowish basally; anterior and middle tibiæ dark reddish brown; head and prothorax chalybeate blue.
subchalybeata Miwa.

CLEOMENINI

Genus MIMISTENA Pascoe, 1866

Mimistena PASCOE, Proc. Zoöl. Soc. London (1866) 513 (Type: *femorata* PASCOE, op. cit. pl. 41, fig. 6, Penang).
Cleomenida SCHWARZER, Entom. Blätter 21 (1925) 29 (Type: *setigera* SCHWARZER, loc. cit., Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 309, 310 (= *Mimistena*).

MIMISTENA PULCHELLA (Gressitt).

Cleomenida pulchella GREISSITT, Philip. Journ. Sci. 57 (1935) 189 (Riran, Formosa).

Since *Cleomenida* is synonymous with *Mimistena*, the above substitution must be made.

This species is smaller than the others, but agrees quite well with them in structure, except that the third antennal segment is relatively a little shorter and the fourth a bit longer. It differs from *femorata* Pascoe, the type of *Mimistena*, in having the prothorax more constricted basally and the posterior femora more suddenly swollen and clavate for a smaller proportion of their respective lengths. The antennæ have the scape green, the remainder brownish, instead of blackish and white in the middle, as in *femorata*. The prothorax is largely orange instead of black, the legs and ventral surface green instead of black, and other differences.

LAMIINÆ

PHRISSOMINI

Genus DOLOPHRADES Bates, 1884

This genus is new to the Formosan fauna, having been known hitherto only from Japan proper, where the type and only previously known species, *D. terrenus* Bates, occurs.

DOLOPHRADES SUBDENUDATUS Gressitt sp. nov. Plate 1, fig. 6.

Female.—Grayish brown, blackish or pinkish in part; largely clothed with tawny brown pubescence; head blackish brown, densely clothed with pubescence; palpi reddish testaceous; antennæ dull reddish brown on scape and apices of following segments, bases of third to last segments light reddish brown, clothed with pale buffy pubescence; prothorax dull brown, densely clothed with tawny pubescence; scutellum thickly covered with golden pubescence; elytra dark brown, largely clothed with dirty tawny brown, but with irregular glabrous patches, particularly in middle portion, ventral surface dark brown, pinkish on sides of abdominal segments, entirely clothed with thin, but close, silvery buff pubescence.

Head nearly as wide as deep, moderately punctured on frons, closely and finely punctured on occiput and nearly impunctate on antennal supports; frons barely higher than wide, subrectangular; vertex concave, grooved medially; eyes with inferior lobes vertical, narrowed ventrally, occupying one-half distance between antennal insertions and bases of mandibles. Antennæ twice as long as body, slender; scape subcylindrical, two-thirds as long as third segment; third segment longer than fourth; fourth to tenth gradually diminishing in length. Prothorax as broad as long, slightly broader at apex than base, hardly swollen above, weakly constricted near base and apex, armed at each side with a short, but strong tubercle placed a little before middle; surface finely and closely punctured except below lateral tubercles. Scutellum raised, broader than long, rounded behind. Elytra broadened to just beyond middle, narrowed posteriorly, separately and narrowly rounded apically; disc convex beyond depressed base; sides fairly well deflexed; surface densely, though irregularly, punctured over entire surface, about seventeen punctures across middle of each and about thirty-five between base and apex along sutural row. Anterior portion of prosternum, and mesepisternum sparsely punctured; remainder of ventral surface impunctate; first abdominal segment as long as second and third together, last practically as long as third and fourth combined. Femora feebly swollen, hind pair reaching fourth abdominal segment; first hind tarsal segment as long as following two segments combined.

Length, 12.5 to 13.2 millimeters; breadth, 4.3 to 4.5.

Male.—Narrower than female; inferior eye lobes extending a little more than one-half way from antennal insertions to bases of mandibles; antennæ two and one-third times as long as body;

elytra parallel at basal half; narrowed posteriorly, more distinctly and sparsely punctured, denuded areas black; last abdominal segment shorter than two preceding united; posterior femora reaching last abdominal segment.

Length, 10.2 millimeters; breadth, 2.9.

Holotype, female (No. 52192, United States National Museum), Hori (Horisha), central Formosa, altitude 650 meters, June 21, 1932; allotopotype, male, author's collection, Bukai, east of Hori, altitude 900 meters, June 14, 1934; paratype, female, Chirifu, southeast of Rokki, southwestern Formosa, altitude 750 meters, May 19, 1934, van Dyke collection, California Academy of Sciences; paratype, female, Hassenzan, north central Formosa, altitude 1,200 meters, June 24, 1934, author's collection, taken by the author.

Differs from *D. terrenus* Bates, of Japan, in being broader, more densely punctured, and in having bare patches on the elytra. One of the female paratypes has the antennæ only one-half again as long as the body.

MONOCHAMINI

Genus PSACOTHEA Gahan, 1888

PSACOTHEA HILARIS (Pascoe).

Monohammus hilaris PASCOE, Trans. Ent. Soc. London 4 (2) (1857) 103 (North China).

Diochares flavoguttatus FAIRMAIRE, Ann. Soc. Ent. Belg. 31 (1887) 133.

Psacothea hilaris GAHAN, Ann. & Mag. Nat. Hist. 2 (6) (1888) 400; MATSUMURA, Thous. Ins. Japan 3 (1908) pl. 52, fig. 3; MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 322.

Psacothea hilaris var. *machidai* SEKI, Entomological World 3 (1935) 292 (Tokyo, Japan).

Psacothea hilaris subsp. *albomaculata* KANO, Kontyu 6 (1933) 278 (type locality: Kirai, Formosa; also Loochoo Islands).

Kano's subspecies cannot hold, for I have examined over one hundred specimens from various localities in Formosa and compared them with typical examples from north central China, and find no characters to justify subspecific separation. The coloration of the pubescent spots is variable among specimens from any locality, and, moreover, among my material from Formosa the spots are more generally yellowish white or yellow and rarely pure white, and thus vary as do examples from the mainland or Japan proper. Specimens from the Loochoos and Kotosho are blacker and have paler spots, but even these are

hardly worthy of separation. At any rate Kano's name cannot apply to these, as the type locality of *albomaculata* is in Formosa.

Genus MONOCHAMUS Guerin-Meneville, 1826

Xenohammus Schwarzer⁴ must be placed as a synonym of *Monochamus*. I have examined specimens of both sexes of forms which agree exactly with the descriptions and figures of both of Schwarzer's species, and find no justification for their placement in the Xenoleini or their separation from *Monochamus*. Both are almost identical in structure with *Monochamus subfasciatus* of Japan and *M. bimaculatus* of India. *Monochamus filicornis* Gressitt⁵ is identical with, and preoccupied by, *Xenohammus bimaculatus* Schwarzer, but as it is a true *Monochamus*, and as Gahan has already used *bimaculatus* for a *Monochamus*,⁶ *bimaculatus* Schwarzer is a homonym and must be replaced by *filicornis* Gressitt. If my conclusions are correct, Schwarzer's error is a very peculiar one, as he had questionably recorded *M. bimaculatus* Gahan from Formosa previous to describing *Xenohammus bimaculatus*, and *filicornis* is exceedingly similar to *bimaculatus* Gahan, particularly in the round black spot behind the middle of each elytron. The principal differences are the slenderer build and grayish, instead of rusty, coloration of *filicornis*. I propose the following corrections:

MONOCHAMUS FILICORNIS Gressitt.

Monochammus filicornis GRESSITT, Philip. Journ. Sci. 55 (1935) 383
(type locality: Hori, Formosa).

? *Monochamus bimaculatus* SCHWARZER (nec Gahan, 1888), Entom. Blätter 21 (1925) (Kosempo, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 324.

Xenohammus bimaculatus SCHWARZER, Senckenbergiana 13 (1931) 204, fig. 22 (type locality: Kosempo, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 347.

I have collected specimens at Hori, Kuraru, and Chirifu (near Rokki), as well as in southeastern China.

Distribution.—Formosa (Kosempo, Hori, Kuraru, Chirifu, Fushoshio, Hozan); South China.

MONOCHAMUS NEBULOSUS (Schwarzer).

Xenohamnus nebulosus SCHWARZER, Senckenbergiana 13 (1931) 205, fig. 15 (type locality: Kosempo, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 347.

⁴ Senckenbergiana 13 (1931) 204.

⁵ Philip. Journ. Sci. 55 (1935) 383.

⁶ Ann. & Mag. Nat. Hist. 2 (6) (1888) 260.

I have collected specimens at Hori and Bukai in central Formosa. Mr. Masayo Kato, of Tokyo, has a specimen which he took at Shichito, Formosa.

Distribution.—Formosa (Kosempo, Hori, Bukai, Shichito).

MONOCHAMUS FASCIOGUTTATUS Gressitt sp. nov.

Female.—Moderately small, abbreviated; antennæ fairly thick. Jet black, irregularly clothed with white to yellowish pubescence, dense in parts, forming a median band and scattered spots on elytra; head sparsely clothed with white pubescence on genæ and lower portions of frons, glabrous on vertex and occiput; antennæ largely clothed with silvery black pubescence, annulated with white on basal halves of fourth to tenth segments and on base and apex of last; prothorax irregularly clothed with small tufts or spots of pubescence, largely tawny on disc and lower parts of sides and whitish on middle of sides and sternum, either side of middle of disc nearly glabrous, a round spot of pubescence above, and just behind, each lateral tubercle; scutellum densely clothed with pale tawny; elytra with a large spot at middle of each, forming a transverse band, broken at suture, remainder irregularly spotted, some larger spots nearly forming a narrow fascia halfway between median band and apex, most of the spots yellowish, median band largely white; ventral surface largely covered with small patches of pale pubescence, largely confluent on abdomen; mesepimeron and apex of metepisternum thickly clothed with tawny; legs thinly clothed with white hairs on femora (except apices) and at middle of each tibia, remainder black.

Head quite coarsely granulate, narrowly concave between antennal supports; frons nearly as wide as high, broader below than above, weakly swollen, inferior eye lobes nearly as wide as deep, barely occupying one-half distance between antennal insertions and bases of mandibles. Antennæ one and three-fourths length of body; scape strongly thickened apically, three-fifths as long as third segment; fourth to sixth subequal; third and following segments thickened apically. Prothorax broader than long, thickly and briefly tuberculate at each side, swollen across middle of disc, sparsely granulated. Scutellum short and rounded. Elytra less than twice as broad, not covering abdomen, separately rounded apically; surface finely granulose and irregularly punctured. Metasternum coarsely, and abdomen finely, granulose.

Length, 15 millimeters; breadth, 5.5.

Holotype, female, Hassenzan, altitude 2,100 meters, north central Formosa, June 24, 1934, loan deposit, California Academy of Sciences, taken by the author.

Differs from *M. subfasciatus* Bates, of Japan, in being shorter, less regularly, and in parts much more thickly, clothed with pubescence, with a distinct band and many rounded spots on elytra, and in having the antennal supports closer, the antennæ thicker, the prothorax more bluntly tuberculate, the elytra more sparsely, and less deeply, punctured, the ventral surface rougher, and in other features. Differs from *M. dubius* Gahan, of Burma and China, in being spotted less regularly, with paler pubescence, and in having the antennal segments unspined internally, the elytra less punctured and the legs black instead of reddish, and in other respects. Differs from *M. filicornis* Gressitt in being broader, less evenly clothed with pubescence, and in having a broad band and spots of light pubescence, instead of a round postmedian black spot on each. This species may very likely be the form recorded as *M. subfasciatus* Bates by Miwa in his Catalogue of the Coleoptera of Formosa. It is also possibly a subspecies of *M. sparsenotatus* Pic, of China.

Key to the Formosan species of Monochamus.⁷

1. Elytra granulose or asperate basally; prothorax moderately strongly tuberculate laterally 2.
- Elytra even and punctured basally; prothorax very weakly tuberculate. 3.
2. Elytra asperate and coarsely granulose basally; occiput rugulose-punctate; color rusty brown, mottled with white and black; length over twenty millimeters..... *tesserula* White.
- Elytra and occiput finely granulose; color black, banded and spotted with thick pale yellow or white pubescence; length under twenty millimeters *fascioguttatus* Gressitt.
3. Body largely clothed with tawny brown pubescence, a round, black spot just behind middle of each elytron; vertex forming a right angle between antennal insertions *filicornis* Gressitt.
- Body largely clothed with pale gray pubescence; elytra irregularly mottled with brownish black pubescence; vertex forming an obtuse angle between antennal insertions *nebulosus* (Schwarzer).

Genus DIHAMMUS Thomson, 1864

DIHAMMUS PERMUTANS subsp. PAUCIPUNCTATUS Gressitt subsp. nov.

Dihammus sericeomicans? SCHWARZER, Entom. Blätter 21 (1925) 59
(Kankau, Formosa).

⁷ *Monochamus flocculatus* Gressitt [Philip. Journ. Sci. 57 (1935) 188] may be more properly placed in the genus *Dihammus*.

Monochamus permutans MIWA, Gov. Res. Inst., Formosa, Dept. Agr. Rep. 55 (1931) 198 (=sericeomicans FAIRM.) (Horisha, Nanto, Kan-shirei, Arisan).

Dihammus sericeomicans MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 329.

Male.—Large, narrowed posteriorly; black, very densely clothed with shiny golden pubescence, which, particularly on elytra, lies in different directions, giving a highly varied pattern of pale gold and velvety brown, largely marbled into small spots according to the angle of vision, and with a suggestion of two broad, incomplete dark bands, one before, and one behind, middle, the apical portions also darker when viewed from above; antennæ with scape and bases of following segments clothed with grayish pubescence, apices of third to tenth, and middle of last, black, thinly clothed with brown; frons, scape, and legs entirely clothed, lacking black spots; scutellum evenly clothed with pale buff pubescence.

Head deeper than wide, very sparsely punctured; vertex narrowly and subacutely concave between antennal insertions; frons hardly swollen. Antennæ two and one-third length of body; scape a little more than one-half length of third segment; fourth to tenth subequal, shorter than third; last twice as long as tenth; scape minutely punctured; third and following segments thickened at apices. Prothorax nearly as long as broad at base, subcylindrical, quite strongly tuberculate laterally; surface fairly deeply punctured along either side of midline of disc and more finely so behind anterior margin and between lateral tubercles and postmedian portion of disc. Scutellum narrowed and rounded apically, nearly as long as broad. Elytra distinctly narrowed posteriorly, irregularly rounded apically; surfaces asperate-punctate, subgranulate basally, moderately, and in part seriatel, punctured externally, finely punctured internally and apically. Ventral surface smooth, no punctures visible through pubescence; legs very finely punctured; first hind tarsal segment hardly as long as following two combined.

Length, 22 to 29.5 millimeters; breadth, 7 to 10.

Female.—Broader than male; elytra less attenuated; antennæ clothed with paler pubescence on basal portions of third and following segments; scutellum broader.

Length, 29 to 30 millimeters; breadth, 10 to 11.

Holotype, male (No. 52193, United States National Museum), Bukai, east of Hori, central Formosa, altitude 1,000 meters.

June 15, 1934, taken by the author; allotype, female, and paratype, male, Hassenzan, north central Formosa, altitude 950 meters, June 25, 1934, taken by the author; paratype, male, Giran, northeastern Formosa, altitude 50 meters, July, 1920, collected by M. Kato; paratype, female, Suisha, central Formosa, altitude 750 meters, May 28, 1932, in the author's collection; paratype, male, Hassenzan, June, 1934, van Dyke collection, California Academy of Sciences, taken by the author.

This subspecies differs from *D. permutans* (Pascoe),⁸ of China, in having the pubescence less finely marbled, the frons, scape, and femora evenly clothed with pale pubescence, and lacking deep black punctures, the prothorax less densely punctured and the elytra less coarsely granulated basally.

Key to the Formosan species of Dihammus.

1. Third and fourth antennal segments of male strongly thickened and flattened; elytra less than twice as long as broad; prothorax about as long as broad at base..... 2.
Third and fourth antennal segments of male not strongly thickened and flattened; elytra more than twice as long as broad; prothorax broader than long 3.
2. Largely pale tawny pubescent; elytra each with a basal brown spot.
subfuscus maculihumerus Matsushita.
Dark brown, elytra with many spots of thick, dark pubescence surrounded by golden brown *flocculatus* (Gressitt).
3. Prothorax sparsely punctured; size large, over eighteen millimeters long. 4.
Prothorax very densely punctured; size small, length under fifteen millimeters *contemptus* Gahan.
4. Antennal insertions strongly raised, vertex angulately concave between them 5.
Antennal insertions weakly raised, vertex broadly rounded-concave between them 6.
5. Body golden-pubescent; elytra with pubescence lying in different directions, giving a highly variable pattern, coarsely granulose-punctate basally *permutans paucipunctatus* Gressitt.
Body evenly brown pubescent; scutellum tawny; elytra finely punctured basally *cervinus* (Hope).
6. Prothorax strongly tuberculate laterally; elytra brown mottled with grayish, irregularly, but fairly evenly, punctured over entire surface. ? *formosanus* Breuning.
Prothorax weakly tuberculate laterally; elytra reddish brown along suture, silvery buff laterally, subseriatelyst punctured, the punctures hidden by thick pubescence, disappearing before apices. *speciosus* Gahan.

⁸ Trans. Ent. Soc. London 4 (2) (1857) 103 [Monohammus].

Genus CYRIOCRATES Thomson, 1868

CYRIOCRATES ALBOPICTUS Matsushita.

Cyriocrates albopictus MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 333, pl. 4, fig. 2 (type locality: Formosa).

Melanauster elegans KANO, Kontyu (Tokyo) 6 (1933) 279 (type locality: Horisha, Formosa).

Melanauster splendidus KATO (nomen nudum), Entomological World 1 (1933) 557, fig. 588 (type locality; Shinchiku, Formosa).

Cyriocrates elegans MATSUSHITA (nec Gahan, 1888), Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 435. (*M. elegans* Kano in *Cyriocrates*, and *C. albopictus* are synonymous with it.)

This species was first described as *Melanauster elegans* by Kano, but since it actually belongs in the genus *Cyriocrates*, Kano's *elegans* becomes a homonym, preoccupied by *Cyriocrates elegans* Gahan⁹ and must be suppressed. The next available valid name is *albopictus* Matsushita, which was synonymized with *elegans* Kano by Matsushita himself, in the same work in which the former was described.¹⁰ *Melanauster splendidus* Kato, which was listed and illustrated as *Melanauster splendidus* Gressitt, appeared before *albopictus* Matsushita, but must be considered invalid, since it was only a manuscript name and was not characterized, the illustration not being sufficient to distinguish it from certain Indian or southern Chinese forms.

Genus ARISANIA Gressitt, 1936

Arisania GRESSITT, Philip. Journ. Sci. 61 (1936) 106 (type: *submarginata* GRESSITT, pl. 1, fig. 16).

This genus, doubtfully placed after the Hippopsini in the original designation, belongs more properly in the tribe Monochamini, though the form is very slender, the antennal scape is long and narrowly cicatricized, the third and following antennal segments are subequal in length, the prothorax is barely tuberculate, and the legs are very short. The characters placing it in the Monochamini are the subrectangular frons, the presence of a closed cicatrix on the antennal scape, the hardly ciliated undersurfaces of the antennæ, the long elytra in comparison to head and prothorax, the closed and externally angulated anterior coxal cavities, the externally open middle coxal cavities, the long metasternum, and the divaricate tarsal claws. The genus has no close relatives known to me.

⁹ Ann. & Mag. Nat. Hist. 2 (6) (1888) 450.

¹⁰ Beiträge zur Kenntnis der Cerambyciden des Japanischen Reichs.

MESOSINI

Genus **FALSOMESOSELLA** Pic, 1925**FALSOMESOSELLA HORISHANA** Gressitt sp. nov. Plate 1, fig. 9.

Male.—Blackish brown, slightly reddish brown on antennæ and tarsal claws, largely clothed with brown, tawny, and grayish white pubescence as follows: Head clothed with dull tawny brown except for some white on middle of frons; antennæ sparsely clothed with dull tawny, basal halves of third and following segments grayish white, undersurfaces clothed with erect dark cilia; prothorax sparsely clothed with mixed tawny and gray hairs, middle of disc nearly glabrous; scutellum tawny; elytra mottled, largely dull brown mixed with tawny, a moderately broad irregular grayish white band, spotted with dark brown dots just before middle, a narrower, much less distinct, light fascia before apex; ventral surface and legs almost entirely clothed with grayish hairs, somewhat tawny on elytra.

Head strongly swollen in front, obtusely concave between antennal insertions, finely, but subasperately punctured; frons deeper than broad, wider above; eyes very deeply constricted, inferior lobes very small, oblique. Antennæ one-fourth longer than body; scape somewhat flattened, expanded ectoapically, three-fourths as long as scape, subequal in length to fourth; fifth two-thirds as long as fourth. Prothorax a little broader than long, swollen laterally, rather densely asperate-punctate, except on some small areas along middle of disc. Scutellum rounded. Elytra slightly broadened posteriorly, rounded-truncate apically, coarsely and irregularly punctured over entire surfaces, asperately so at bases. Femora very short, clavate.

Length, 7.4 millimeters; breadth, 2.5.

Holotype, male, Hori (Horisha, Polisia), central Formosa, altitude 550 meters, June 9, 1934 (loan deposit, California Academy of Sciences) taken by the author.

Differs from *F. hakka* Gressitt, of South China, in having the prothorax and elytra longer, the vertex more concave, the elytral punctures asperate and less seriate, and the elytra with a single premedian broad light band, instead of a basal and a postmedian one. Differs from *gracilior* Bates in being darker brown and less spotted with black, and in having the prothorax more swollen and the elytra less even and asperate.

FALSOMESOSELLA SUBALBA Gressitt sp. nov. Plate 1, fig. 10.

Female.—Dull reddish brown, almost entirely clothed with pubescence as follows: Head largely clothed with white, mottled with tawny above and at sides; antennæ clothed with grayish white spotted with tawny, apices of segments sparsely clothed, showing reddish derm; prothorax clothed with white, mixed with tawny, pubescence; scutellum white; elytra largely clothed with white on basal half, a brown spot on middle of each at first quarter and some tawny pubescence along costæ, posterior half mottled brown, tawny and white, an incomplete, zigzag brown band at middle; ventral surface and legs largely clothed with grayish white.

Head swollen anteriorly, grooved medially, subrounded-concave between antennal insertions; eyes deeply emarginate, inferior lobes small, deeper than wide. Antennæ one-fifth longer than body; scape flattened and produced ectoapically, nearly as long as third segment and slightly longer than fourth; fifth two-thirds as long as fourth. Prothorax broader than long, feebly rounded at each side, slightly swollen on either side of disc, fairly strongly punctured. Scutellum rounded. Elytra very slightly broadened posteriorly, rounded-truncate posteriorly; surface of each feebly tricostate and subseriatately punctured, a few subasperate punctures near base. Metasternum sparsely punctured. Femora short and swollen, hind pair not reaching last abdominal segment, the latter as long as three preceding segments combined, and medially grooved.

Length, 8.3 millimeters; breadth, 3.2.

Male.—Antennæ one-half again as long as body; last abdominal segment only as long as two preceding segments combined.

Length, 10 to 12 millimeters; breadth, 4 to 4.4.

Holotype, female (No. 52194, United States National Museum), Kuraru, Koshun district, near South Cape, Formosa, altitude 160 meters, May 8, 1934, taken by the author; allotopotype, male, June 1932, Gressitt collection, taken by Y. Yano; paratopotype, female, Tsuda, May 1935, Gressitt collection; paratopotype, female, May 3, 1934, Lingnan Natural History Survey Museum, Canton, China, taken by the author.

Differs from the preceding in having the vertex more rounded-concave, the antennæ longer, the prothorax less closely punctured, the elytra more even, more finely and regularly, and less asperately, punctured, and in other respects. Easily distinguished from *hakka* Gressitt, *gracilior* Bates, or *horishana* Gres-

sitt by its body being largely clothed with white pubescence, and spotted or streaked with tawny.

NYCTIMENINI

Genus EUSEBOIDES Gahan, 1893

EUSEBOIDES MATSUDAI Gressitt sp. nov. Plate 1, fig. 2.

? *Euseboides plagiatus* KANO, Trans. Nat. Hist. Soc. Formosa 18 (1928) 408 (Karenko and Koshun, Formosa) (nec Gahan, 1893); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 354.

Blackish brown to rusty brown; bases of antennal segments, margins of elytra, trochanters, tarsi and apical abdominal segments reddish; irregularly clothed with tawny pubescence as follows: Head sparsely clothed, prothorax with longitudinal stripes of pubescence, a very faint stripe along midline of disc, some broader, subconfluent stripes along sides of disc and upper portions of sides; scutellum densely clothed; elytra sparsely clothed, a little more densely so along middle of sides, a small spot of dense pubescence on costa just behind middle and a short oblique band one-fifth from apex, apices moderately clothed; sides of thorax moderately clothed; abdomen with five incomplete longitudinal stripes of denser pubescence; antennæ clothed with very thin pale pubescence, and a few short erect hairs.

Head feebly convex in front, rounded-concave between antennal insertions, closely and finely punctured; frons squarish; eyes deeply emarginate, coarsely facetted, inferior lobes deeper than wide. Antennæ one-third longer than body; scape cylindrical, slightly arched, one-fourth longer than third segment; third slightly shorter than fourth, subequal to fifth and following. Prothorax one-third longer than broad, as wide as head, three-fourths as wide as elytra, feebly constricted before and behind middle, finely and closely punctured. Scutellum small, rounded behind. Elytra four times as long as broad, parallel; apices slightly narrowed, obliquely truncated and strongly and subacuminately produced externally; surfaces finely punctured, most densely so on humeri, each with two obtusely raised ridges, one suboblique, from humerus to near suture at apical fifth, the other parallel to external margin, extending from humerus to apical sixth. Ventral surface quite regularly punctured; first abdominal segment nearly twice as long as each of following, which are subequal. Legs short; posterior femora fairly slender, extending to middle of second abdominal segment; first segment

of hind tarsus slightly longer than second and third segments united.

Length, 10.5 millimeters; breadth, 1.6.

Holotype, male (No. 52195, United States National Museum), Hori (Horisha), central Formosa, altitude 600 meters, September, 1930; paratotype of same sex in author's collection. Both received from Mr. Y. Matsuda, of Kyoto, for whom the species is gratefully named, and in whose collection there are additional specimens.

Differs from *Euseboides plagiatus* Gahan, of Sikkim, in being only two-thirds as long, narrower at the shoulders, with the elytra more parallel, more divaricate and acuminate apically and lighter preapically and less pale postbasally, the prothorax less cylindrical and relatively longer, and the posterior femora not reaching apex of second abdominal segment.

ACANTHOCININI

Genus CLYTOSEMIA Bates, 1884

? *CLYTOSEMIA BICINCTA* Gressitt sp. nov. Plate 1, fig. 3.

Slender, depressed, subparallel. Reddish brown; upper portion of head, and middle of sides of prothoracic disc brownish black; apical half of elytra chocolate brown, except along suture, partially clothed with pubescence; tibiae dull brown; antennae light reddish brown basally, third and following segments dull brown, their extreme bases reddish. Body clothed as follows: Head with thin silvery-white pubescence and erect dark hairs; antennae sparsely pubescent, ciliate internally to seventh segment, cilia in a single row on fifth to seventh segments; prothorax with thin pale pubescence and erect black hairs; scutellum thinly pubescent; elytra likewise, nearly glabrous basally, two transverse glabrous dark brown bands posteriorly, first just behind middle, second between latter and apex, pubescent portions dotted with small, round, glabrous spots, entire surface with suberect setæ; ventral surface and legs thinly pubescent, latter with some erect dark setæ.

Head feebly convex, almost plane between antennal insertions, finely granulose; genal angles prominent; frons transverse; eyes coarsely faceted, inferior lobes suboblique, about as wide as deep. Antennae slender, one-third longer than body; scape subcylindrical, slightly thickened medially, nearly as long as third segment; fourth longer than third; fifth to seventh each subequal to third. Prothorax nearly one-half again as long as broad, narrower at base than at apex, briefly and sharply spined

at each side a little behind middle; surface finely granulose, moderately swollen above. Scutellum short, rounded. Elytra long, subparallel, narrowed and rounded apically, obtusely tuberculate near base, finely and closely punctured. Ventral surface finely granulose; metepisternum very narrow; first abdominal segment one-half again as long as second. Legs slender; femora compressed, clavate apically; first segment of posterior tarsus hardly longer than following two segments together.

Length, 5.4 millimeters; breadth, 1.2.

Holotype, male? (loan deposit, California Academy of Sciences), Sakahen, near Karenko, eastern Formosa, altitude 1,200 meters, July 15, 1934, taken by the author.

Differs from *C. pulchra* Bates, of Japan proper, in having the vertex less concave, the scape less swollen, the prothorax longer and spined, instead of tuberculate, laterally, the antennæ more briefly ciliate, the scutellum smaller, the elytra more tuberculate, the anterior and middle coxae more approximate, the body more distinctly setose, and in other features. The genus is new to Formosa.

Genus RONDIBILIS Thomson, 1857

RONDIBILIS FEMORATUS Gressitt sp. nov. Plate 1, fig. 1.

Brownish black; elytra dull reddish brown; pro- and mesosterna, coxae, metepisterna, and deflexed portions of humeri reddish; clothed with pubescence as follows: Head thinly and evenly clothed with dull silvery; antennæ very thinly clothed with silvery pubescence; prothorax sparsely and somewhat irregularly clothed, the pale pubescence broken by indistinct brown spots, and narrowly and irregularly along suture and three or four other longitudinal stripes on disc; ventral surface thinly and evenly clothed; legs very sparsely pubescent. Body bristles very short, sparse and feebly raised, only discernible on dorsal surfaces of elytra; antennæ very sparsely bristled below.

Head very shallowly concave between antennal insertions; moderately concave anteriorly, finely granulose; eyes swollen, inferior lobes fully as wide as deep, occupying three-fourths distance from anterior tubercles to bases of mandibles. Antennæ slender, two-thirds again as long as body; scape very slightly thickened towards apex, subcylindrical, nearly as long as third segment; fourth very slightly longer than third or fifth, following gradually shorter. Prothorax one-third again as long as broad, constricted anterior to base, slightly swollen laterally, and very feebly and bluntly tuberculate behind middle of each side; disc hardly swollen, finely granulose. Scutellum triangular. Ely-

tra narrow, very slightly attenuated posteriorly; apices narrowed and emarginate-truncate, outer angle briefly toothed; surface finely and subseriatelv punctured, a strong tubercle at end of basal quarter. Legs fairly long, femora swollen, hind pair nearly reaching elytral apices; tibiæ arched; first segment of hind tarsus slightly longer than remaining combined.

Length, 4.8 to 6.5 millimeters; breadth, 1.3 to 1.8.

Holotype, male (No. 52196, United States National Museum), Rokki (Rokkiri), southwestern Formosa, altitude 350 meters, May 15, 1934; allotopotype, female, May 12, and paratype, male, near Chirifu, east of Rokki, altitude 600 meters, May 19, 1934, in author's collection, all taken by the author.

Differs from *R. horiensis* Kano (*mushensis* Matsushita) in being smaller, with the vertex less concave, the eyes much larger, the prothorax less cylindrical, the elytra less oblique apically and not asperate-punctate, and the dorsal surface much less bristly, less pubescent, and lacking dark spots or bands.

Genus MIÆNIA Pascoe, 1864

MIÆNIA GRANULICOLLIS Gressitt sp. nov. Plate 1, fig. 5.

Female.—Dull reddish brown; head, except mouth parts, and prothorax, except anterior and posterior borders, brownish black; femora, except bases and apices, and tibiæ, except bases, dark brown. Body clothed with grayish white pubescence as follows: Head and prothorax largely, but thinly, clothed, the latter subglabrous on either side of scutellum, a moderately broad, suboblique band at end of first third, a slightly narrower and less complete band before apical quarter, and some irregular spots between latter and apices; ventral surface thinly and evenly clothed; apical margin of first abdominal segment with a short, but dense, fringe of hairs; antennæ with a single row of short cilia on undersides of second to seventh segments.

Head hardly concave between insertions, finely grooved medially, finely punctured; frons broader than high, slightly convex; eyes deeply emarginate, inferior lobe as broad as deep. Antennæ fine, one-half as long as body; scape subcylindrical, slightly longer than third segment; fourth nearly one-half longer than third and one-third longer than fifth; following gradually diminishing. Prothorax broader than long, slightly narrower at base than at apex; each side with a slender and slightly recurved spine a little behind middle; disc finely granulose. Scutellum rounded-truncate. Elytra subparallel, narrowed and rounded apically, finely and subseriatelv punctured to apices, a feeble

carina along edge of lateral declivity. Posterior femora reaching to apical quarter of elytra; first segment of hind tarsus as long as following two united.

Length, 5 millimeters; breadth, 1.7.

Holotype, female (No. 52197, United States National Museum), Kuraru, Koshun district, near South Cape, Formosa, altitude 175 meters, May 9, 1934; paratotype, female, May 8, author's collection; both taken by the author.

Differs from *M. subfasciata* Schwarzer in being broader, with the eyes larger, the scape less arched, the third antennal segment much shorter than the fourth, the prothorax broader with longer spines, its surface granulose instead of punctate, the elytra less heavily and less regularly punctured, dark with light bands instead of light with an incomplete dark fascia, and in other respects.

Genus EXOCENTRUS Mulsant, 1839

EXOCENTRUS TESTUDINEUS subsp. **BREVISETOSUS** Gressitt subsp. nov. Plate 1, fig. 4.

Female.—Dull chocolate brown, anterior and posterior borders of prothorax, prosternum, trochanters, bases of femora, and apices of tarsi reddish; body clothed with pale pubescence as follows: Head thinly clothed over most of surface; prothorax thinly clothed, a distinct oblique spot on either side, and a fine midlongitudinal line, on disc; scutellum fairly densely clothed; elytra each with a faint longitudinal stripe extending back from base interior to humerus and a suboblique one extending from near suture behind scutellum, both meeting a narrow transverse band that reaches external margin but does not quite touch suture, next a longitudinal stripe along middle of dorsal disc, crossing slightly over the preceding band and extending to middle where it dichotomously divides, the two branches continuing obliquely, the inner to suture, the outer an equal distance and turning and continuing transversely to external margin, and lastly a zigzag band just beyond beginning of apical quarter; ventral surface moderately clothed; antennæ with very short, slightly raised, dark hairs, and moderate, suberect internal bristles; body bristles short, strongly oblique on dorsal surface, very sparse on pronotum and legs.

Head feebly swollen, hardly concave at vertex, finely granulose; inferior lobes of eyes as broad as deep. Antennæ one-third longer than body; scape slightly thicker at middle than at apex, a little longer than third segment; third to fifth segments subequal; following slightly shorter. Prothorax about twice as broad as long, strongly produced laterally, with an obliquely

backward directed spine behind middle of each side; surface finely granulose. Scutellum short, rounded. Elytra broad, parallel, rounded externally at apices; surfaces closely and irregularly punctured to apices. Last abdominal segment nearly as long as three preceding together. Femora moderately swollen.

Length, 4 millimeters; breadth, 1.5.

Holotype, female (loan deposit, California Academy of Sciences), Bukai, near Hori, central Formosa, altitude 950 meters, June 12, 1934, taken by the author.

Differs from *E. testudineus* Matsushita,¹¹ of Japan proper, in having the bristles much shorter, sparser, and thicker, the elytral punctures much coarser and covering entire surface, the antennæ and legs darker, and in other respects.

EXOCENTRUS VARIEPENNIS (Schwarzer).

Camptomyne? variepennis SCHWARZER, Ent. Blätter 21 (1925) 147
(type locality: Kankau, Formosa).

A specimen taken by me at Kuraru, Koshun, southern Formosa, May 8, 1934, appears to be referable to Schwarzer's species. Though Schwarzer does not state that the body is clothed with erect bristles, my specimen agrees with the original description as far as it goes, unless "Fühler einfach" means that the antennæ are unciliated beneath, rather than merely unarmed or not swollen. The species seems to be a true *Exocentrus*, so I transfer it from *Camptomyne*. This would provisionally eliminate *Camptomyne* from the fauna of Formosa. My specimen measures three and one-half millimeters in length, is reddish brown with three irregular fasciae of spots of white pubescence on the elytra, and has the antennæ clothed with fairly long bristles internally and the elytra with long and thick bristles sparsely placed.

Key to the Formosan species of Exocentrus.

1. Legs densely clothed with bristles; elytra finely striped longitudinally.. 2.
Legs very sparsely clothed; femora practically glabrous; elytra with transverse fasciae or reticulate pubescent markings..... 3.
2. Prothorax red, less than twice as broad as long; elytra lacking a postmedian transverse fascia..... *rufithorax* Gressitt.
Prothorax reddish brown, clothed with gray pubescence, more than twice as broad as long; elytra with a postmedian transverse fascia.
seriatomaculatus Schwarzer.
3. Pubescent markings forming a subreticulate pattern on elytra; bristles very short, strongly oblique dorsally; elytra irregularly punctured.
testudineus brevisetosus Gressitt.
Pubescent markings on elytra in three transverse fasciae; bristles long and erect; elytra distinctly seriate-punctate....*variepennis* (Schwarzer).

¹¹ Trans. Sapporo Nat. Hist. Soc. 22 (1931) 47.

SAPERDINI

Genus SERIXIA Pascoe, 1856

SERIXIA GRISEIPENNE Gressitt sp. nov. Plate 1, fig. 8.

Female.—Largely black, antennæ and ventral portions of body partly testaceous; head reddish testaceous except labrum, tips of mandibles and eyes, which are black; antennæ black, becoming brownish black towards apices; prothorax reddish testaceous, slightly blackish at sides; scutellum and elytra entirely black; meso- and metapleura and sides of abdominal segments largely blackish; thoracic and abdominal sterna and posterior margins of abdominal pleura testaceous; legs largely black, tarsal claws, coxae, and basal halves and undersurfaces of femora testaceous. Body clothed with pale gray pubescence and fine erect pale hairs, the former fairly dense on elytra, giving a gray effect; antennæ finely ciliate on undersides of first four segments.

Head slightly broader than prothorax, convex, grooved medially, moderately heavily punctured on frons and vertex; frons as high as wide; vertex feebly concave between antennal insertions; eyes with inferior lobes about as wide as deep. Antennæ slender, a little more than twice as long as body; scape subcylindrical, three-fourths as long as third segment; third and following segments subequal in length. Prothorax one-third broader than long, constricted before and behind middle, deeply and irregularly punctured. Scutellum short, subtruncate. Elytra parallel, rounded apically, subobliquely seriate-punctate along middle of dorsal surface and at edge of lateral declivity, irregularly punctured on remainder. Posterior femora reaching last abdominal segment.

Length, 8.2 millimeters; breadth, 2.3.

Holotype, female (loan deposit, California Academy of Sciences), Sakahen, near Karenko, eastern Formosa, altitude 1,050 meters, July 15, 1934, taken by the author.

Differs from *S. sinica* Gressitt, of southeastern China, in being more pubescent, much more closely punctured on prothorax and elytra, less seriatel so on the latter, and in having the scutellum and pleura largely black instead of testaceous. Distinguishable from *S. atripennis* Pic by its more pubescent and more densely and less regularly punctured elytra, broader and more punctate prothorax, paler ventral surface, and in other features. Differs from *S. testaceicollis* Kano in having the prothorax pubescent, and the antennæ and legs largely black.

SERIXIA SUBSERICEA Gressitt sp. nov. Plate 1, fig. 11.

? *Serixia longicornis* SCHWARZER, Ent. Blätter 21 (1925) 149 (Kosempo and Kankau, Formosa).

Female.—Orange testaceous, elytra reddish testaceous; antennæ dull brown, first three segments and apices of following segments black; tips of mandibles, eyes, tarsi, tibiæ, and apices of femora largely black; tarsal claws reddish. Body clothed with pale silky pubescence, fairly dense on elytra; antennæ clothed with a short pile and finely ciliate on undersides of first four segments.

Head moderately convex, plane between antennal insertions, finely and not very densely punctured; frons wider than high; eyes deeply constricted, inferior lobe slightly wider than deep. Antennæ slender, twice as long as body; scape subcylindrical, feebly arched, four-fifths as long as third segment, third and following subequal in length. Prothorax one-third again as broad as long, feebly constricted near base and apex, finely and irregularly punctured. Scutellum short, rounded-truncate behind. Elytra parallel, only slightly more than twice as long as broad, deeply punctured in about five regular longitudinal rows along middle of disc, from base to apex, irregularly and more finely punctured near suture and lateral margin. Ventral surface nearly impunctate. Posterior femora barely reaching apical sixth of elytra; first segment of hind tarsus no longer than third.

Length, 8.5 millimeters; breadth, 2.8.

Holotype, female (loan deposit, California Academy of Sciences), Kuraru, Koshun district, near South Cape, Formosa, altitude 150 meters, July, 1934.

Differs from *S. longicornis* (Pascoe) in being larger, more reddish, and in having the third antennal segment entirely, and the legs largely, black. Differs from *S. signaticornis* Schwarzer in having the ventral surface of body testaceous instead of black.

Key to the Formosan species of Serixia.

- | | |
|--|---------------------------------|
| 1. Elytra partly, or entirely, testaceous..... | 2. |
| Elytra entirely black | 4. |
| 2. Elytra entirely yellowish or reddish testaceous; antennæ dull..... | 3. |
| Elytra black on apical quarter; antennæ testaceous (Botel-Tobago Island) | <i>botelensis</i> Kano. |
| 3. Ventral surface of body black; basal antennal segments brown. | |
| | <i>signaticornis</i> Schwarzer. |
| Ventral surface of body testaceous; basal antennal segments black. | |
| | <i>subsericea</i> Gressitt. |

4. Legs largely, or entirely, testaceous; antennæ largely brown or dull testaceous 5.
 Legs largely black, more or less testaceous at bases of femora; antennæ and thoracic and abdominal pleura largely black 6.
5. Sides of body clothed with dense silvery-white pubescence; first three antennal segments black, remainder dull testaceous basally and black apically; legs pale testaceous *albopleura* Gressitt.
 Sides of body lacking white pubescence; antennæ dark brown; legs dull testaceous *testaceicollis* Kano.
6. Elytra thinly pubescent, fairly regularly punctured; femora largely black; ventral surface entirely black, shiny *atripennis* Pic.
 Elytra densely pubescent, closely, and more or less irregularly, punctured; femora largely testaceous on basal halves and undersides; thoracic and abdominal sterna partly testaceous; pleura dull black.
 *griseipenne* Gressitt.

PHYTŒCIINI

Genus EPIGLENEA Bates, 1884

EPIGLENEA COMES subsp. FORMOSANA (Schwarzer).

Daphisia formosana SCHWARZER, Ent. Blätter 21 (1925) 153 (type locality: Taihorin, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 416.

Epiglenea comes subsp. *formosana* KANO (nec Schwarzer), Trans. Nat. Hist. Soc. Formosa 18 (1928) 127 (type locality: Musha, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 426.

Daphisia formosana Schwarzer is no more than subspecifically distinct from *Epiglenea comes* Bates, and is identical with, and preoccupies, *E. comes formosana* Kano. As *comes* is the type species of *Epiglenea*, the above revision is provisionally correct, but *Epiglenea* may later prove to be an invalid genus.

Distribution.—Formosa (Taihorin, Hozan, Musha, Hori, Taito, Kosempo), Taihoku.

JAPANESE NAMES

1. *Macrotoma fisheri formosæ* subsp. nov. Togefuchi-ō-usuba-kamikiri.
2. *Macrotoma katoi* sp. nov. Sekobutogefuchi-usuba-kamikiri.
3. *Epania subglabra* sp. nov. Kurokobane-kamikiri.
4. *Mimistena pulchella* (Gressitt). Ao-kenaga-kamikiri.
5. *Dolophrades subdenudatus* sp. nov. Taiwan-beitosu-higenaga-kamikiri.
6. *Psacothea hilaris* (Pascoe). Kiboshi-higenaga-kamikiri (Taiwan-kiboshi-kamikiri).
7. *Monochamus filicornis* Gressitt. Futamon-higenaga-kamikiri.
8. *Monochamus nebulosus* (Schwarzer). Kumo-higenaga-kamikiri.
9. *Monochamus fascioguttatus* sp. nov. Hoshiobi-higenaga-kamikiri.
10. *Dihammus flocculus* (Gressitt). Futo-higenaga-kamikiri.

11. *Dihammus permutans paucipunctatus* subsp. nov. Kinke-higenaga-kamikiri.
12. *Cyriocrates albopictus* Matsushita. Hade-ō-shirahoshi-kamikiri.
13. *Falsomesosella horishana* sp. nov. Horisha-hime-gomafu-kamikiri.
14. *Falsomesosella subalba* sp. nov. Shiro-hime-gomafu-kamikiri.
15. *Euseboides matsudai* sp. nov. Arakawa-kamikiri.
16. ? *Clytosemia bicincta* sp. nov. Futaobi-dōboso-kamikiri.
17. *Rondibilis femoratus* sp. nov. Momobuto-dōboso-kamikiri.
18. *Mixenia granulicollis* sp. nov. Sunakubi-keshi-kamikiri.
19. *Exocentrus testudineus brevisetosus* subsp. nov. Taiwan-kikkō-chibi-kamikiri.
20. *Exocentrus variepennis* (Schwarzer). Monmadara-keshi-kamikiri.
21. *Serixia griseipenne* sp. nov. Nezumiba-higeboso-kamikiri.
22. *Serixia subsericea* sp. nov. Kikiro-higeboso-kamikiri.
23. *Epiglenea comes formosana* (Schwarzer). Monki-kamikiri (Taiwan-yotsuboshi-kamikiri).

ILLUSTRATIONS

PLATE 1

[Magnified 4 times.]

- FIG. 1. *Rondibilis femoratus* Gressitt sp. nov., holotype.
2. *Euseboides matsudai* Gressitt sp. nov., holotype.
3. *Clytosemia bicincta* Gressitt sp. nov., holotype.
4. *Exocentrus testudineus* subsp. *brevisetosus* Gressitt subsp. nov., holotype.
5. *Mixenia granulicollis* Gressitt sp. nov., holotype.
6. *Dolophrades subdenudatus* Gressitt sp. nov., holotype.
7. *Epania subglabra* Gressitt sp. nov., holotype.
8. *Serixia griseipenne* Gressitt sp. nov., holotype.
9. *Falsomesosella horishana* Gressitt sp. nov., holotype.
10. *Falsomesosella subalba* Gressitt sp. nov., holotype.
11. *Serixia subsericea* Gressitt sp. nov., holotype.

TEXT FIGURE

- FIG. 1. *Macrotoma katoi* Gressitt sp. nov., $\times 1$.

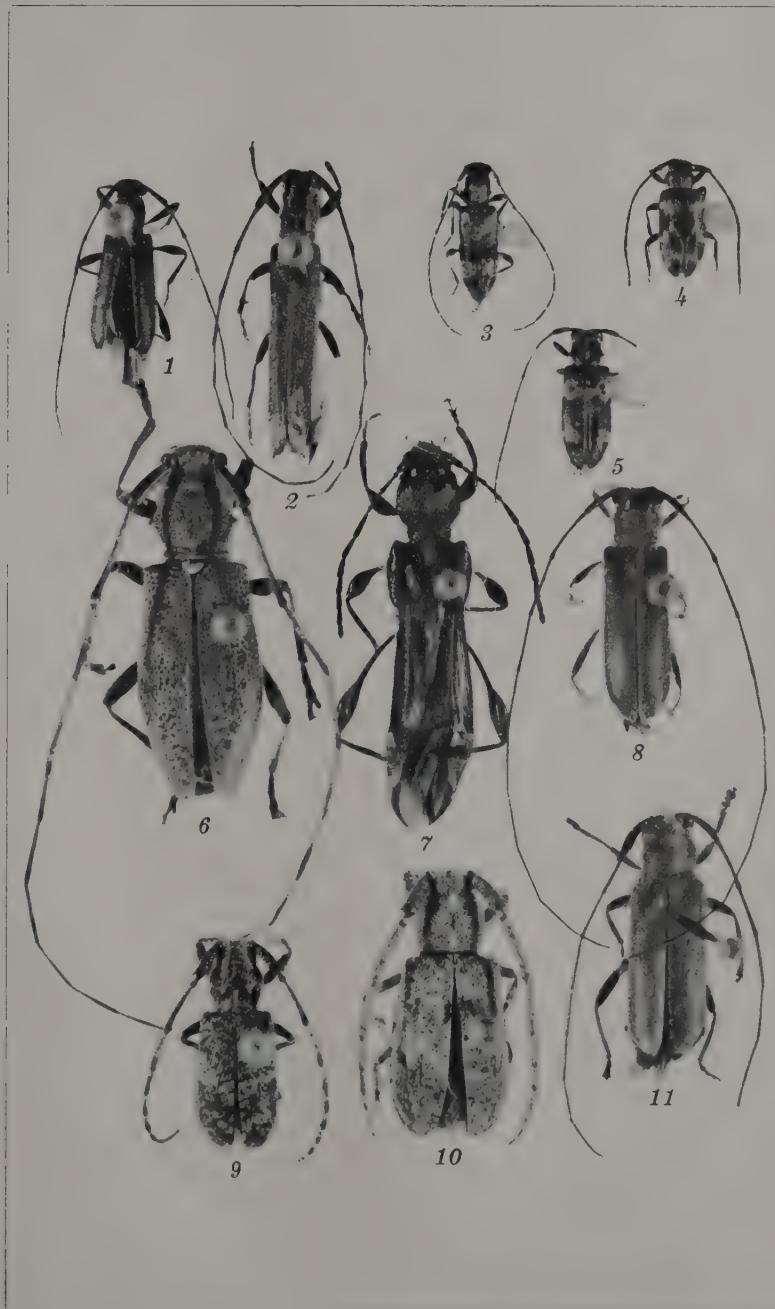


PLATE 1.

THE FISHERY INDUSTRIES OF RAGAY GULF

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THREE PLATES AND EIGHT TEXT FIGURES

Ragay Gulf, 43 miles wide at the entrance and extending 60 miles inland to the northwest, is one of the southern indentations of Luzon. With Viñas River entering its head, it almost divides Luzon at this point. Although the waters at the head of the gulf are generally muddy due to the sediment carried down by the rivers emptying there, the gulf as a whole is deep and clear, the shores being fringed with narrow coral reefs interspersed with sand and gravel beaches.

The western coast is a portion of Tayabas Province, and the eastern, of Camarines Sur Province. Burias Island, Masbate Province, and the islands and shoals north of it, divide the entrance of Ragay Gulf into two wide channels. Thus the fisheries of the gulf really fall under the jurisdiction of three provinces. Like those of the other regions of the Philippines, the activities largely depend upon the prevailing monsoon. So in this gulf, fishing is centered along the western coast (Tayabas Province) during the southwest monsoon and along the eastern coast (Camarines Sur Province) during the northeast monsoon.

Although the greater portion of the gulf is too deep and too rocky for trawling, there is a good patch of sea where the beam trawls operate; namely, towards the head of the gulf in the neighborhood and under the jurisdiction of the municipality of Guinayañgan.

Table 1 shows the income of the different municipalities from the fisheries. It readily shows that fishing activities in Ragay Gulf center around the municipalities of Guinayañgan, Tayabas Province; Pasacao, Camarines Sur Province; and San Pascual, Masbate Province. In the following paragraphs the status and importance of these fisheries are graphically presented.

San Narciso.—San Narciso is an agricultural town situated at the head of Port Pusgo, with fishing for local consumption carried on mostly inside the Port. The larger part of the Port

TABLE 1.—*Incomes from fisheries of Ragay Gulf.*

Municipality.	1935	1934	1933	1932	1931
San Narciso		392.00	466.00	530.00	966.00
Guinayañgan		679.00	1,227.25	2,030.00	2,405.75
Ragay	246.00	17.62	204.00	369.50	335.00
Sipocot ^a	111.25	46.76	33.75	265.00	218.75
Pamplona	90.95	76.00	99.00		12.00
Pasacao	400.00	504.00	312.00	227.50	74.80
San Fernando	60.00	90.00	10.00	35.00	4.00
Bula ^a	353.57	330.00	258.00	92.00	192.75
San Pascual	973.00	970.00	1,127.00	791.00	911.00
Total		3,211.22	3,921.50	4,329.50	5,206.55

^a Incomes only partly derived from the Ragay Gulf fisheries.

is a shoal less than 2 fathoms deep, and about $\frac{1}{2}$ mile further in may be found mud bottom. The Boholano style of fish corral is the most common fishing gear. *Sakag*, *salap*, ordinary fish corral, and *salambao* are other gear of less importance.

Along the portion of the Port with muddy bottom is the source of raw materials for a thriving bêche-de-mer industry, consisting in the collection and curing of trepang for shipment to Manila. This industry is engaged in mostly by the Boholanos. During the southwest monsoon the open-sea fisheries are exploited by beam trawlers for bottom or ground species, and by the *largarete* fishermen for the sardines and herrings.

Guinayañgan.—Guinayañgan is the largest town in Ragay Gulf. The water within its jurisdiction is rich in both pelagic and demersal species. It may be considered the fishing center of Ragay Gulf, because the majority of the fishermen operating there are either permanently or temporarily residing in one or the other of the barrios of Manglayô and Aloneros.

Manglayô, on the northern outskirts of Guinayañgan, is the center of fishing activities. Here live the fishermen, both resident and immigrant, the latter mostly Caviteños, Rizaleños, Boholanos, and Bicolanos, who either have permanently established themselves or are mere transients in search of opportunity for good fishing. The *largarete* is the most important gear used for catching herrings, one of the most important commercial species caught in the gulf. The largerete outfits numbered to over one hundred before the typhoon of April, 1935. Many fishermen, mostly immigrant, lost their lives in that freak typhoon. At present there are only about forty such outfits left, although new ones are being equipped for fishing.

Shallow and deep-water fish corrals of the *inangcla* style, sakag and *sibid-sibid*, are other fishing gear used in this locality. The catch is sold either in the fresh-fish market of Guinayañgan or brought to Aloneros for shipment in ice to Manila.

Smoking and drying of herrings (mostly *tunsoy* and *lapad*) are done by both the natives and the Chinese. Three smoke houses and drying sheds owned by Chinese are actively operating. The natives also dry and salt fish, but their sheds are not regular establishments. The smoked and salted fish are sold locally or sent to various towns in Tayabas and to Manila. Often these herrings are simply immersed in brine and boiled and sent to Manila for final smoking.

Dynamiting and poisoning of fish by means of *bayate* have been reported rampant around Tagcauayan Bay. The apprehension of these violators of the law is emphatically demanded of the authorities by those engaged in the catching of fish by legal methods.

The barrio of Old Aloneros, or simply Aloneros, is situated eight miles up Viñas River. It is really the central landing of the major catch from the gulf for shipment in ice to Manila by rail. It is the center of the fish business, where wholesalers purchase the larger catches of the individual fishermen. Here also reside the Japanese owners of four beam trawlers—Angeles, Rosy, Koshindo Maru, and Ryojuku Maru—that operate in the municipal waters of Guinayañgan. Aside from the insular fishing license, the municipality charges each trawler a fee of 70 pesos every three months for the privilege of fishing. This the Japanese owners pay without question, just to avoid interruption and delay in their fishing activities. The Japanese trawlers fish in the open waters of the gulf to as far as Capuluan Reef and Peris Bay.

There are two smoke houses, one owned by a Filipino and the other by a Chinese. Mr. Kong Long Hai, the owner of the second smoke house, also owns a motor boat that collects the catch of the largarete and takes it to his curing shed for preservation.

Ragay.—Ragay town is in the interior, but exercises jurisdiction over a portion of the sea fisheries of Ragay Gulf in the neighborhood of Catabañgan, and Ragay Bay indentations to the northeast, all rich fishing grounds for herrings, mackerels, hardtails, and other species. The town itself is 5 to 6 kilometers from Ragay Gulf, and accessible from the gulf by Ragay River.

The fishermen of this region are concentrated in small sitios of the barrios of Catabañgan and Port Ragay.

Catabañgan is famous for its lumber mill, and is, in fact, a very progressive barrio because of the lumber industry. About three hundred largarete outfits were registered before the storm of April, 1935. Now (1936) there are only about 50. The fleet of largarete fishermen is generally towed by motor boats to rich fishing grounds for herrings to as far as the barrio of Oboyon in Peris Bay. The catches are collected by the same motor boats for marketing in the fresh, but mostly in the cured, state.

Both shallow and comparatively deep fish corrals dot the shore. Sibid-sibid (hand-line) fishermen contribute to the daily supply of fresh fish for employees of the lumber mill. It was gleaned that these hand-line fishermen are the ones employing illegal means of catching fish, using dynamite and fish poison to such an extent that they even manufacture their own explosives when the regular dynamites are not procurable.

Port Ragay, then the railroad connection of the Tayabas and Bicol lines, is a small barrio founded in 1932. Fishermen, mostly the largarete crew, live in a portion of this barrio. The largarete outfits are towed by motor boats to rich fishing areas. Fish corrals and hook and line fishing are also engaged in to some extent.

Sipocot.—Although this town is also in the interior, being located at a point almost midway between Ragay Gulf and San Miguel Bay, it exercises jurisdiction over a portion of the waters of the Gulf in Caima Bay. Fishing conditions and fishing methods here are almost identical to those obtaining and practised in Catabañgan and Port Ragay.

Pamplona.—Like Ragay, Pamplona is also in the interior, with a very limited extent of sea fisheries, covering over a small portion of the coast along the gulf. The location of the town is, however, significant, in that the catch of the large-sized species that are sent from Pasacao to Manila is shipped from this point of the Manila Railroad. The fishing gear employed are the shallow and deep-water fish corrals.

Pasacao.—The town lies at the head of the cove, in the valley leading through high land to the town of Pamplona. It used to be the connection of the Tayabas-Bicol lines. The fishing grounds under its jurisdiction are quite rocky and deep, and hence not favorable for trawling.

Inside the cove are fish corrals of the inangcla style, both shallow and deep-water. Other gear used here are the *cabiao* and the *sibid-sibid*.

A thriving local enterprise consists in the wholesale buying of all catch by one person, Mr. Gregorio Olivan, who stores them in ice and ships them to Manila by rail. Mr. Olivan also owns many *sibid-sibid* outfits that fish for him around Burias Island. The catch of the *sibid-sibid* fishermen are the large-sized fishes of varied species usually seen in the fresh-fish markets of Manila. In effect, these constitute one of the principal sources of fresh fish in the City. The small species are generally sent to Naga and the neighboring towns. All the large and medium-sized species caught in various gear (*sibid-sibid* generally) are sorted and iced, and then sent to Manila by rail. The wholesale buying prices obtaining locally and the wholesale selling prices prevailing in the markets of Manila for the different species are given in Table 2.

TABLE 2.—Wholesale buying and wholesale selling prices of large and medium-sized species in Pasacao, and in Manila markets, respectively, in centavos.

Species.	Buying price per kg.	Selling price per kg.
Bisugong laot	12	30
Lapu-lapu	15	40
Turiñgan	12	30
Maya-maya	12	30
Rompe	12	25
Tañigigi	20	40
Sortidos	12	25

The fishing season occurs during the northeast monsoon because the fishing ground is somewhat exposed during the southwest monsoon. There are no preservation plants locally, and the catch is temporarily stored in ice before shipment to Manila. The ice is supplied by the plant of the Camarines Sur Industry Company located at Magarao, Camarines Sur. A limited amount of the catch is either dried or salted for local consumption.

San Fernando.—San Fernando is another interior town exercising control over a portion of the coastal waters of the gulf. The barrio of Cotmô is especially significant, because of the rich fishing ground, where no less than seven fish corrals, ranging in depth from 18 to 27 meters, are located. This is a

rich fishing ground for various species of tunas and bonitos, especially during the northeast monsoon and trade winds.

Bula.—Like San Fernando, but eastward of it is the municipality of Bula, also an interior town with the sea fisheries very limited, confined only to that portion of the gulf after the municipal jurisdiction of San Fernando. The fishing conditions are similar to those of San Fernando. Its major fishery consists of fresh-water resources in the lakes and rivers (Lake Baao and Bicol River).

San Pascual, Burias Island.—San Pascual is the only municipality in Burias island at the mouth of the Gulf. It is situated in the northern part of the island. The whole island is pasture land, where thousands of cattle graze the cogon hills.

Fishing is also a profitable enterprise, where the activity shifts with the monsoon—rich on the northeastern coast during the southwest monsoon and on the southwestern coast during the northeast. There is a long coast line with an abundance of fish life where coral-reef fishes of varied species abound. The gear popularly employed are the sibid-sibid and the fish corral (ordinary and *pahubas*). The sibid-sibid is the principal source of large-sized fishes that are stored at Pasacao and marketed at Manila.

COMMERCIAL SPECIES CAUGHT

Because of the extensive operation of four Japanese beam trawlers that fish almost every day of the year, the most important species composing the bulk of the catch from the gulf are the bottom or "ground" species that frequent smooth sea bottom of either sand or mud, where the trawls can be properly operated. Unlike the catch from Manila Bay, however, the hauls from this region consist of the larger fishes. Such fishes as the slipmouths (*Leiognathidae*), lizard fishes (*Synodontidae*), crevalles (*Caranx* spp.), nemipterids (*Nemipteridae*), theraponids (*Theraponidae*), goatfishes (*Mullidae*), croakers (*Sciænidæ*), mojarras (*Gerridae*), and shrimps (*Penæus* spp.) are, therefore, not infrequently seen among the fish landed at Aloneros for shipment to Manila. The fish corrals make the same hauls, with the difference that during runs of pelagic fishes the latter compose the bulk of the hauls, which, being floating or "surface" species, are never intentionally caught in the trawls.

Herrings (*Sardinella* spp.), mackerels (*Scombridæ*), bag-eyes (*Caranx crumenophthalmus*), round scads (*Decapterus* spp.), and bonitos (*Thunnidæ*) are the pelagic migratory species

that are frequently caught in the various fish traps and fish nets at certain seasons of the year. Rock or coral-reef fishes, such as the groupers (Serranidae), snappers and pristipomoids (Lutjanidae), and large nemipterids, are the principal hauls of the sibid-sibid fishermen of Burias Islands.

Other species of less commercial importance, as they are caught in lesser amounts, are listed in Table 3 with their vernacular names.

TABLE 3.—A list of species caught in Ragay Gulf.

English name.	Tayabas Tagalog.	Bicol (Ragay Gulf).	Scientific name.
Anchovy.....	Bolinao.....	Dilis.....	Engraulidae.
Deep-bodied.....	Tegui.....	Tegui.....	<i>Scutengraulis</i> spp.
Barraaucudas.....			Sphyraenidae.
Large.....	Rompe.....	Rompe.....	Do.
Small.....	Sega-segaro.....	Titso.....	Do.
Bonito.....	Tulifangan.....	Turifangan.....	<i>Euthynnus</i> spp.
Carangoid fishes.....		Rayado.....	<i>Auxis</i> spp.
Cavallas.....	Sebo.....	Mamsa.....	Carangidae.
		Baolo.....	Do.
Crevalles.....	Salay-salay.....	Atoloy.....	<i>Caranx malabaricus</i> (Bloch and Schneider).
Hardtail.....	Pak-an.....	Pakan.....	<i>Caranx</i> spp.
Leatherjacket.....	Lapis.....	Lapis.....	<i>Megalaspis cordyla</i> (Linnaeus).
Round sead.....		Sibobog.....	<i>Scomberoides</i> spp.
Runners.....	Salmon.....		<i>Decapterus</i> spp.
Threadfish.....		Lawihan.....	<i>Elagatis bipinnulatus</i> (Quoy and Gaimard).
Catfishes.....			<i>Alectis</i> spp.
Sea.....			Nematognathi.
Striped sea.....	Patuna.....	Tabañgongo.....	Ariidae.
Croakers.....		I-ito.....	<i>Plotosus anguillaris</i> (Bloch).
Cutlass fish.....	Spada.....	Abo.....	Sciendidae.
Drepame.....	Kilióng.....	Langkoy.....	<i>Trichiurus haumela</i> (Forskål).
Eel.....			<i>Drepane punctata</i> (Linnaeus).
Fresh-water.....			Apodes.
Flatfish.....	Palad.....	Kasili.....	Anguillidae.
Flathead.....	Lobalob.....	Palad.....	Heterosomatidae.
Flying fish.....	Iliw.....	Itang.....	Platycephalidae.
Garfish:			Exocoetidae.
Round-bodied.....	Tambilauan.....	Balo.....	<i>Tylosurus</i> spp.
Compressed-bodied.....	Salasa.....	Dugso.....	<i>Abelennes hians</i> (Cuvier and Valenciennes).
Gizzard shad.....	Kabasi.....	Kabasi.....	Dorosomidae.
Goatfish.....	Saging-saging.....	Tiao.....	Mullidae.
Grouper.....	Segapo.....	Kugtong.....	Serranidae.
Grunt, thick-lipped.....		Pogapo.....	
Guitar fish.....	Sodsod.....	Nabilan.....	<i>Plectorhinchus</i> spp.
		Arado.....	
		Sorodan.....	<i>Rhynchosbatus djiddensis</i> (Forskål).

TABLE 3.—A list of species caught in Ragay Gulf—Continued.

English name.	Tayabas Tagalog.	Bicol (Ragay Gulf).	Scientific name.
Halfbeak.....	Patlay.....	Bugiw.....	Hemiramphidæ.
Herring.....			Clupeidæ.
Indian sardine.....	Tamban.....	Tursay.....	<i>Sardinella longiceps</i> (Cuvier and Valenciennes).
Fimbriated.....	Tunsoy.....	Tamban Tondo.....	<i>Sardinella fimbriata</i> (Cuvier and Valenciennes).
Deep-bodied.....		Alobabay.....	<i>Sardinella perforata</i> (Cantor).
Fry.....	Malapnè.....		Clupeidæ.
Lactariid.....	Rigodon.....	Algodon; damos.....	<i>Lactarius lactarius</i> (Bloch and Schneider).
Lizard fish.....	Oting bondo.....	Tokö.....	<i>Saurida tumbil</i> (Bloch).
Mackerel.....			Scombridae.
Spanish.....	Tanguingui.....	Tangigi.....	<i>Cybium commerson</i> (Lacépède).
Short-bodied.....	Kabalias.....	Kabalias.....	<i>Rastrelliger brachysomus</i> (Bleeker).
Striped.....	Lumahan.....	Burao.....	<i>Rastrelliger chrysouron</i> (Rüppell).
Milkfish.....	Bafígos.....	Bafígos.....	<i>Chanos chanos</i> (Forskål).
Mojarras.....	Manobon.....	Latob.....	<i>Gerres filamentosus</i> (Cuvier).
Moonfish.....	Tabas.....		<i>Meno maculata</i> (Bloch and Schneider).
Mullet.....	Banak.....	Balanak.....	Mugilidæ.
Large-scaled.....	Ugapang.....		<i>Mugil vaigiensis</i> Quoy and Gaimard.
Nemipterid.....	Bisugo.....	Kanasi.....	<i>Nemipterus japonicus</i> (Bloch).
Pomadasid, spotted.....	Ibalay.....	Kiskisan.....	<i>Pomadasys hastia</i> (Bloch).
Pomfret, black.....	Pampano.....	Pampano.....	<i>Stomateus niger</i> (Bloch).
Silvery.....	Alumbeberas.....		<i>Stromateus cinereus</i> (Bloch).
Porgy.....	Bakoko.....	Bakoko.....	<i>Sparus berda</i> (Forskål).
	Kanuping.....		<i>Lethrinus opercularis</i> (Cuvier and Valenciennes).
Ray.....	Pagi.....	Pagi.....	Batoidei.
Cow-nosed.....		Ogaog.....	<i>Rhinoptera javanica</i> Müller and Henle.
Remora.....	Kini.....	Kini.....	<i>Echeneis naucrates</i> (Linnaeus).
Sailfish.....	Malasugui.....	Malasugui.....	Istiophoridæ.
Sea bass.....	Katoyot.....	Bolgan.....	<i>Lates calcarifer</i> (Bloch).
Sergeant fish.....	Pandaooan.....	Balisokan.....	<i>Rachycentron canadum</i> (Linnaeus).
Siganid.....	Balewin.....	Toros.....	Teuthidæ.
Shark.....	Pating.....	Pating.....	Euseelachii.
Hammerhead.....	Kroson.....	Kroson.....	Leiognathidæ.
Slipmouth.....	Tambong.....	Barorog.....	<i>Scalophagus argus</i> (Linnaeus).
Spadefish.....	Kikiro.....	Kikiro.....	Lutjanidæ.
Snappers.....			
Flame-colored.....	Pargo.....	Agawin.....	<i>Lutjanus fulvus</i> (Bloch and Schneider).
Silver-spotted gray.....	Pargong ilog.....	Tifgarog.....	
Malabar red.....	Polahan.....	Allao.....	<i>Lutjanus argentimaculatus</i> (Forskål).
		Maya-maya.....	<i>Lutjanus malabaricus</i> (Schneider).

TABLE 3.—A list of species caught in Ragay Gulf—Continued.

English name.	Tayabas Tagalog.	Bicol (Ragay Gulf).	Scientific name.
Tarpon.....	Buan-buan.....	Bulan-bulan.....	<i>Megalops cyprinoides</i> (Broussonet).
Threadfins.....		{ Salmingan..... Hogao.....	{ Polynemidae.
Theraponids.....	Gongong.....	{ Kanigit..... Korong-korong.....	{ Theraponidae.
Tuna, large.....	Tambakol.....	Bangkolis.....	Thunnidae.
Whiting.....	Ashos.....	Osohos.....	Sillaginidae.
Pristipomid.....		Manambulao.....	<i>Pristipomoides microdon</i> (Steindachner).
	MISCELLANEOUS CATCHES		
Shrimp.....	{ Balas (small) Balay-hangin..... Pasayan.....	{ Lokon..... Pasayan.....	{ <i>Palænetes</i> spp. <i>Penus</i> spp.
Sea cucumber.....	Balatan.....		Holothurioidea.
Octopus, small.....	Etotos.....		Octopoda.
Crab.....	Kasag.....		<i>Neptunus pelagicus</i> (Linnæus).
Pectin.....	Kapis.....		<i>Pectin</i> sp.

FISHING METHODS

The fishing methods employed in this region range from the simple way of catching fish by the use of spears to the more or less modern commercial beam trawling. While the spear fishermen do their fishing by wading or simply diving from dugouts that are large enough to accommodate only their own bodies, motor boats with spacious holds are used in the trawling operations, enabling the outfits to fish for a much longer time and to cover a much larger territory, returning to land only when they think enough returns will be netted each of the investors in the enterprise.

Japanese beam trawl.—Of utmost commercial importance as a fishing appliance around the Gulf is the beam trawl; at the time of the survey (1936) there were four motor boats in operation, all owned by Japanese and manned by purely Japanese crew—Angeles, Rosy, Koshindo Maru, and Ryojuku Maru.

This fishing appliance and the method of its operation are described in an earlier issue of this Journal.¹

The beam trawlers, which have Old Aloneros as their home port, weigh anchor for the fishing ground at 12 A. M., after receiving their provisions, fish boxes, trays, and ice for the catch.

¹ Philip. Journ. Sci. 48 (1932) 389–410.

Upon arrival at the fishing ground, at about 1 P. M., the net is shot and dragged until about 5 P. M., when it is hauled in. After the catch is collected and the torn portions of the net are repaired, the net is shot for the second time. The second hauling is done at about 11 P. M., after which the net is shot for the last time during that trip. The last hauling occurs at 5 A. M., after which the boats proceed homeward, reaching Old Aloneros at about 8 A. M., just in time to either sell the catch to wholesale dealers or to pack it in fish boxes with crushed ice, ready for shipment to Manila by the 11 o'clock train. This fishing routine is followed usually for seven days in the week, except for two or three Japanese holidays.

The catch is similar to that of the beam trawl in Manila, with the difference that the fishes caught are proportionately much larger and the volume of the individual hauls is greater. The catch of small slipmouths and those of other species are either thrown out or collected in bulk for the line fishermen to be used as bait. One haul nets about 100 kilograms of this miscellany, the proper utilization and conservation of which, when viewed on the basis of the aggregate amount collected by the fleet of beam trawlers, is a real problem.

The commercial catches are sorted on board the vessels during the actual fishing after each haul and on their homeward trip. The fish trays are larger than those used in Manila, measuring $26\frac{1}{2}$ by 15 by $2\frac{3}{4}$ inches, and containing 8 kilograms of fish on the average.

The following are the local wholesale prices of the major catch of the beam trawls:

Kind.	Pesos per tray of 8 kg.
Shrimp	2.80 to 3.00
Nemipterids	0.80 to 1.00
Lizard fishes	0.30 to 0.40
Slipmouths	0.30 to 0.40
Miscellaneous	1.00

Largarete.—The largarete is really a set gill net made to hang from a stationary banca anchored right in the fishing ground, the herrings entangling themselves in the meshes from both sides as they approach the light or lights used to dazzle and perhaps also to attract them. Text fig. 1 shows the fishing device in operation.

The banca used in this method of fishing is an ordinary dug-out from 10 to 11 meters long, 1.10 meters wide, and 0.60 meter deep, or approximately 1.2 gross tons. One side is provided with an outrigger, while the other is free, to permit unobstructed manipulation of the net in the actual fishing operation.

Towards the stern is a detachable bamboo mast to which a canvas sail is hoisted when the wind is favorable in order to

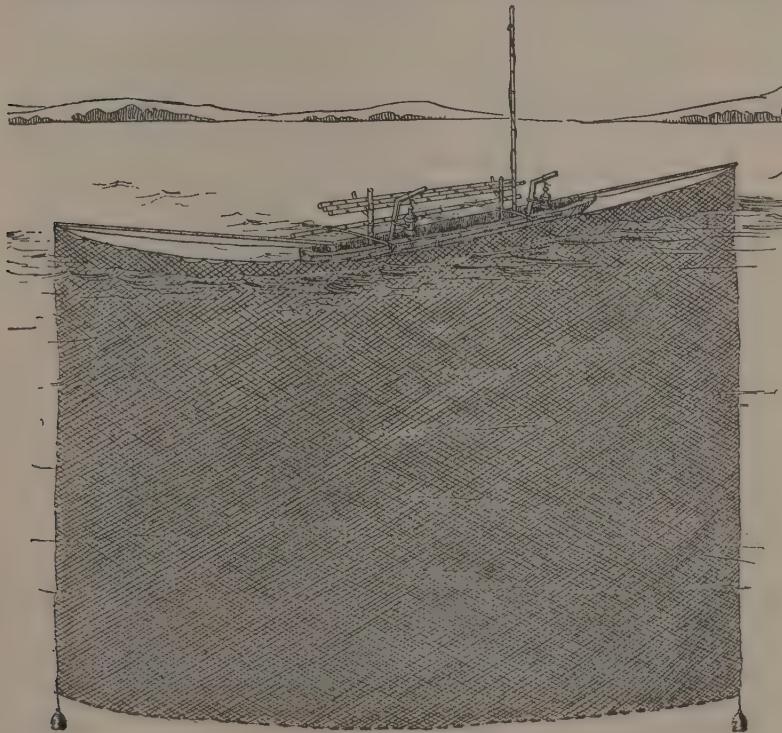


FIG. 1. Largarete in operation.

speed up the trip to and from the fishing ground. For shelter, most of the bancas are provided with a detachable canvas awning. Towards one side, usually the unrigged side, is an improvised open-air stove.

In the actual fishing operation two bamboo poles from 10 to 15 meters long and with a small pulley at the tip are attached to both the bow and the stern of the boat; these poles

are, however, removed when the fishing is over. One to three incandescent petroleum lamps (Continental, Petromax, Standard, or Coleman) from 300 to 2,000 candle power, are hung from wooden stands on the side of the banca.

A largarete outfit is generally manned by four or five men, one being the *piloto*, or the steersman, and the rest the members of the fishing crew.

The net, which is of No. 40² cotton twine, is a curtainlike affair, 1,000 meshes wide and 20 meters deep. The sizes of the webs, which differ with the size of the fish sought, are as follows:

Serial number.	Size of web.	Fishes caught.
1	No. 27	Tunsoy.
2	Nos. 26, 27	Lapad or alobaybay and alañgan.
3	No. 25	Siliniasi or malapnē.

The bottom and cork lines are selvaged with 6 meshes of No. 14 web, while the sides are provided with a 12-mesh strip of No. 14 web selvage. The cork line, instead of carrying corks, is equipped with brass rings 2.5 centimeters inside diameter, attached at intervals of 50 centimeters. To the two ends of this line are attached two sets of 0.5-centimeter cotton cords—the "stretching cords" passed through the pulley and used in stretching the net, and the "retrieving cord," passed through the rings so that, upon being pulled in opposite directions, they cause the net to collapse after the catch is made (text fig. 2). The lead line is provided with 100-gram lead weights strung at intervals of 25 centimeters. At the two extreme ends of the lead line are attached heavy lead weights to serve as anchors for the net.

The approximate cost of a fishing outfit is as follows:

	Pesos.
Nets (at least 3 at 50 pesos each)	150
Banca	100
Lamps (from 1 to 3 at 30 pesos each)	90
 Total	 340

The monthly maintenance, which includes food, drinks, and cigarettes for the crew and petroleum and matches for the lamp, amounts to 100 pesos. Largarete fishermen operate only during moonless nights. They leave port at about 4 P. M., reaching the

* The standards adopted are those of L. R. Aguinaldo as specified in his catalog for 1935.

fishing ground exactly at dusk. The boat is anchored at some rich ground around the Gulf. The lamps are lighted and the two bamboo poles set in place at the bow and stern of the boat. The stretching and the retrieving cords are then attached to the net. The stretching cord is pulled through the pulley at the end of the bamboo pole, and the net spread like a curtain from the side of the boat.

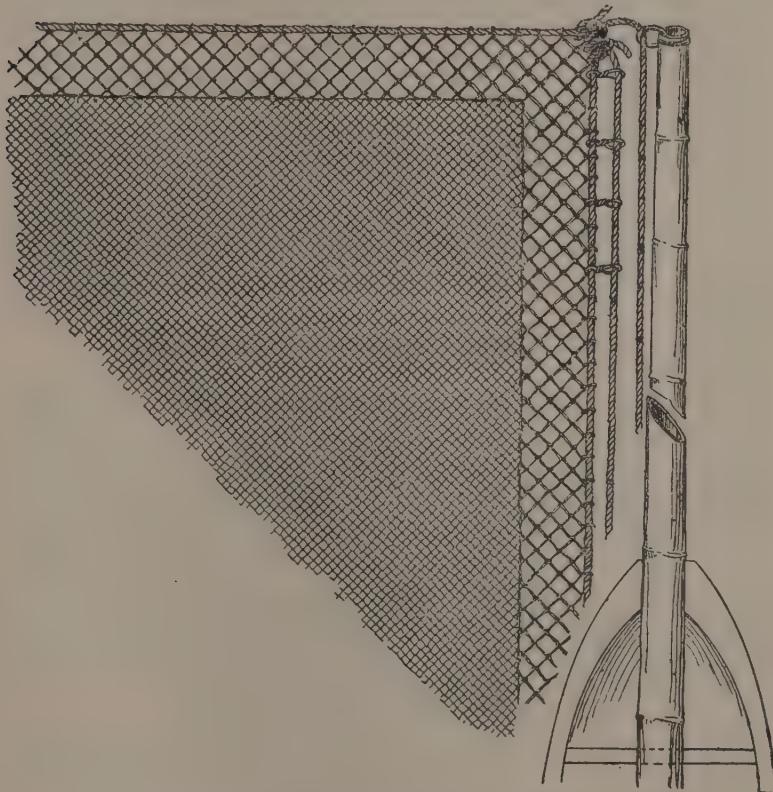


FIG. 2. Detail of stretching and retrieving device of largarette.

After some hours of fishing and as soon as the cork line sags, indicating a quantity of herring entwined in the meshes, the net is hauled in by letting go the stretching cord and pulling on the retrieving cord from opposite directions, that is, the line attached at the bow is pulled towards the stern and vice versa. This action collapses the net which, as a whole, with its load of fish, is hauled into the boat, where it is hung and the entwined fishes picked one by one from its meshes. Once free of fishes, the net

is again spread, and this operation repeated; the same routine is followed from dusk to dawn of the next day, the number of hauls made depending upon the abundance of fish.

Often one or more outfits are towed to rich fishing grounds by a hired motor boat, and the catch collected from each of them the following morning by the same motor boat, so that these largarete outfits need not return to their home until the ground no longer offers good returns. The catch, consisting mostly of herrings, and small amounts of squids, remoras, halfbeaks, mackerels, and barracudas, is sold to the owners of motor boats who are also owners of smoke houses and fish-preservation sheds. In fact, the bulk of the catch of the largarete is cured, only a very negligible portion of it being consumed in the fresh condition.

The division of the income from this method of fishing is as follows: After all the expenses incidental to fishing operations are deducted, the remainder is divided into three parts—one part for the lamp, one part for the net, and the third for the members of the crew, including the piloto who, however, gets an additional bonus from the owner of the outfit.

Fish corrals.—Of third commercial importance as a fishing gear in this region is the age-old fish corral, wherein enormous sums of money are invested annually. These corrals vary in size from the small and shallow-water fish trap along wading depths in beaches and rivers to the large deep-water fish weirs wherein nets (*siguin*) are employed in the collection of the catch. In the shallow or small corrals bamboo stakes are used as supports, while in the deep-water ones *palma brava* are employed as posts. All the fish corrals are planted or constructed with the leaders perpendicular to either of the two coasts—the eastern or western, the pound or collecting portion of the arrangement being in the deeper portion of the gulf.

Although the catch are of varied species, the most common are the anchovies, herrings, mackerels, hardtails, bag eyes, bonitos, and tuna.

As in other fishing grounds of the Philippines, various styles of both the shallow and the deep-water fish corrals are in vogue in Ragay Gulf, foremost among which are the *quinavite* or *inang-la*, the *boholano*, the *pangalato*, the *natural*, and the *pahubas*.

The inangla or the quinavite (text fig. 3) is usually planted in water from 10 to 22 meters deep, although shallow weirs from 2.5 to 4 meters deep are also constructed in this style; in the latter case a pound or crib is provided for, whence the catch is collected by means of a dip net.

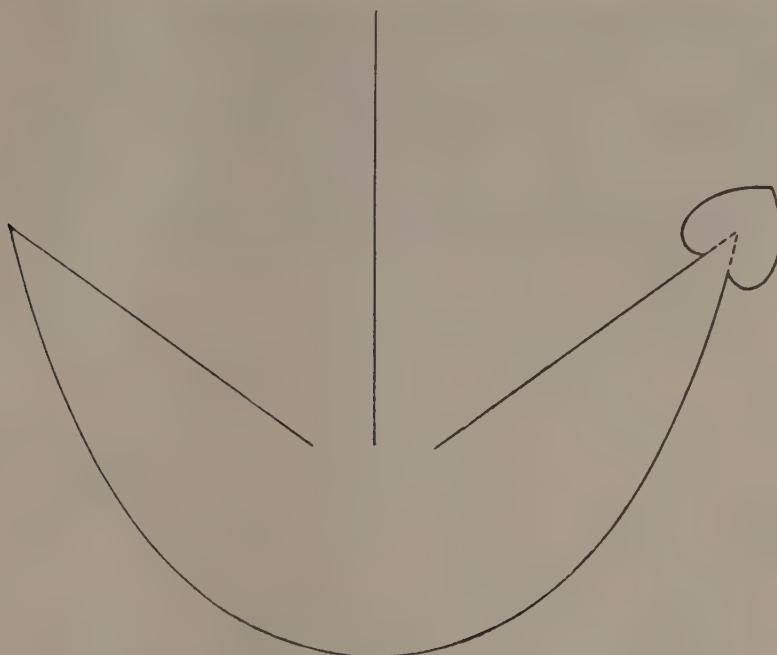


FIG. 3. Quinavite fish corral.

The following expenses are incurred in the construction of a deep-water corral of the inangcla style, as given by Mr. Vicente Torres of Guinayañgan.

Materials and equipment:

	Pesos.
500 Palma brava (bahê) at 60 centavos each	300
2,000 Bamboos (bolô or bohô) at 20 pesos per 1,000	40
20,000 Rattan at 3 pesos per 1,000	60
200 Bamboos for raft (balsa) and bridge (vela) of the tawanik variety at 12 pesos per 100	24
1 Cotton net (siguin)	300
1 Banca	250

Construction:

Cost of splitting 2,000 bolô at 20 pesos per 1,000	40
Cost of weaving the mattings:	

Body of 14 pieces (bantasan)* at 5.80 pesos each	81
Leader of 20 pieces (bantasan) at 5.80 pesos each	116

Labor (by contract):

First maestro	60
Second maestro	50
Seven men at 15 pesos each	105

Grand total	1,426
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* 1 bantasan=21 meters.

The monthly maintenance includes the payment of one *encargado* at 25 pesos and five men as laborers with food at 15 pesos each per month.

The expenses incurred in the construction of a shallow-water fish corral of this style are as follows:

	PESOS.
800 Bamboo poles at 6 pesos per 100	48
2,000 Rattan at 30 centavos per 100	6
200 Banata of the spiny variety of bamboo at 40 pesos per 100	80
1 Net	40
Labor	200
 Grand total	 374

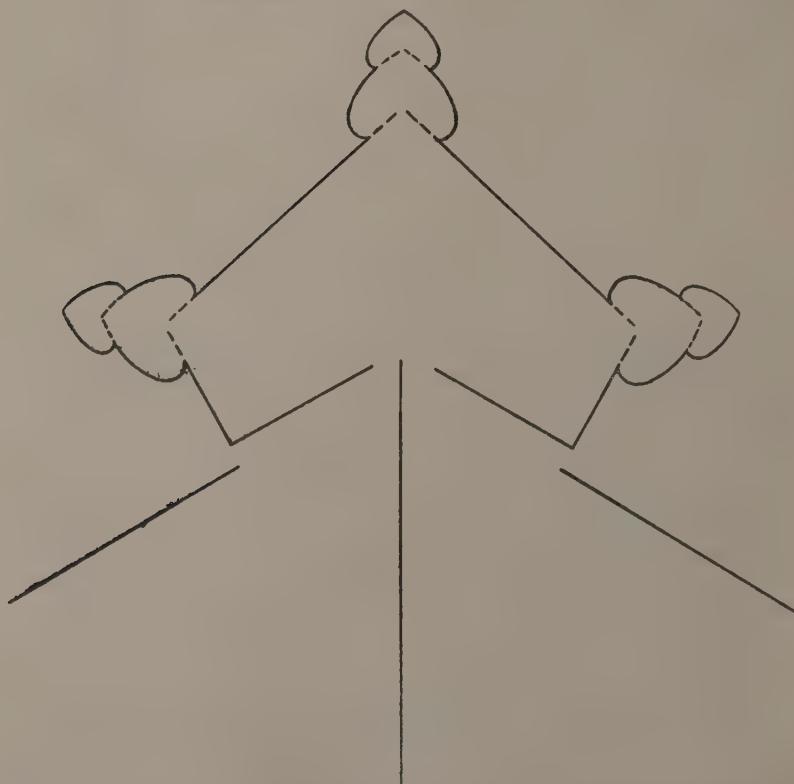


FIG. 4. Boholano fish corral.

The ground plan of the Boholano style is shown in text fig. 4. This shallow-water corral is built at a depth of from 2 to 4 meters, employing *bolō*, *tinikan*, or wire netting as mattings.

This trap necessitates the investment of from 100 to 200 pesos. The net or sugin is used in the pound only.

Text fig. 5 shows the pangalato style, another shallow-water corral, which requires the investment of from 150 to 300 pesos.

Text figs. 6 and 7 are the ground plans of the natural or ordinary corral and the pahubas, respectively, both shallow-water corrals. In the latter style the mattings or a portion of the mattings of the wings are generally lowered during high tide in or-

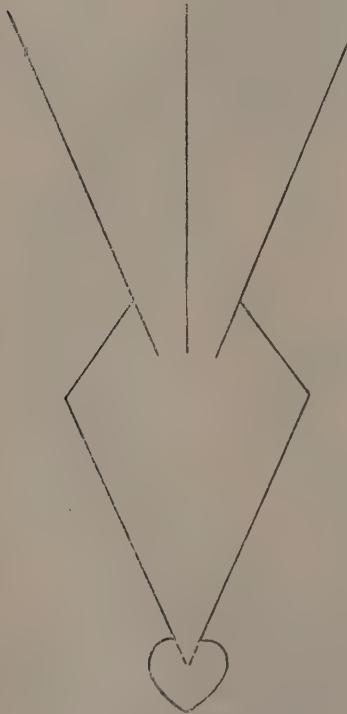


FIG. 5. Pangalato fish corral.

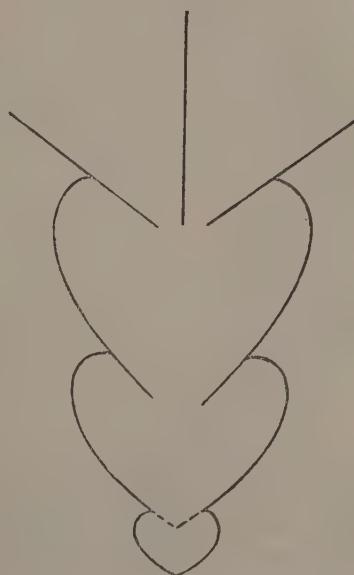


FIG. 6. Natural or ordinario fish corral.

der to permit the entrance of fish, and again made fast to the stakes in upright position at the slack of the tide to prevent the escape of the impounded fishes.

Sibid-sibid.—The sibid-sibid is a troll line consisting of a stout line provided with a hook at one end baited with fresh sardines, shrimps, squids, or white chicken feathers tied around a small bamboo ring. Fishing is done in a fast sailing banca or dugout of the outrigger type. As the line is dragged along

the water from the stern of the boat, the feathers revolve continuously and are supposed to attract the fish. Often these sibid-sibid fishermen are just ordinary hand-line fishermen with the lines no longer dragged but simply baited and allowed to hang from the banca, which drifts with the current and the tide. Light is usually employed in this mode of fishing.

The catch consists of the large game fishes, such as Spanish mackerel, tuna, snapper, grunts, barracudas, whitings, nemipterids, pristipomoids, and sergeant fishes.

Kubkub.—The *kubkub* is a purse seine popularly used in the catching of pelagic species that run in schools; such as the herrings and the mackerels. An outfit is composed of a banca or dugout and a purse seine or net. The banca is similar in

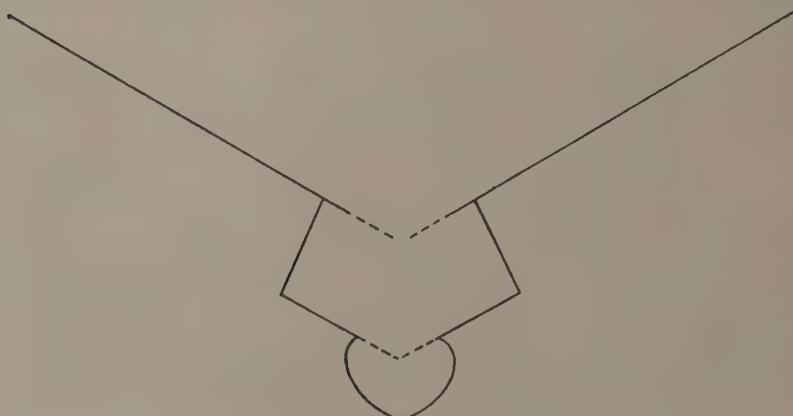


FIG. 7. Pahubas.

construction to that used in largarete fishing, with the difference that in the former it is large, and both the bow and the stern are provided with a groove for the pursing of the line during the pursing operation. This outfit requires from eight to eleven men to operate.

The net is composed of from five to seven pieces, one piece being 2,000 meshes wide and from 15 to 30 meters deep when hung. This seine is built like a shallow curtain without any bag at the middle. Its upper portion is buoyed up with numerous wooden floats (No. 1A) strung 30 centimeters apart on a strong rope, the float line, to keep the seine floating on the surface of the water. The lower edge is weighted with No. 2 lead weights strung along a light rope at intervals of 30 cen-

timeters. The lead line must be ten per cent shorter than the float line to allow the net to be pursed quickly and the bottom strips of the net to bag. Uniformly distributed along the entire length of the lead line and attached by short ropes are a great number of No. 4 brass rings. Through these rings runs the purse line of abaca, about 1 centimeter in diameter, by means of which the net is pursed from the bottom.

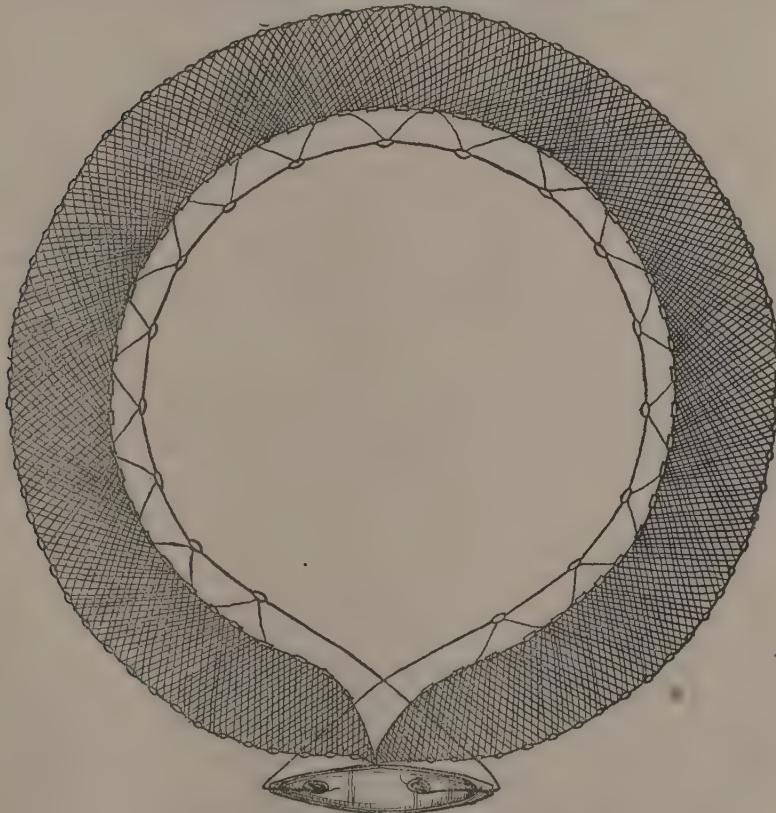


FIG. 8. Kubkub in operation.

The main body of the net is of No. 14 (herring) and No. 10 (mackerel) cotton netting. The bunt or landing bag is of No. 8 (herring) and No. 23 (mackerel) web. The net is selvaged with a 50-centimeter strip of No. 23 (herring) and No. 30 (mackerel) web towards both the float and the lead lines.

Fishing with this gear (text fig. 8) is also done at night, and the catch delivered in the morning. When a school of fish is

sighted, the net is paid out by setting a lighted buoy and entirely encircling the school with the net. The banca is then brought alongside and the pursing lines pulled by hand in opposite directions from both the stern and the bow. The catch is then concentrated in the bunt, whence the fish are brailed out by means of dip nets.

The kubkub catches herrings, mackerels, hardtails, and bonitos, all pelagic species that run in schools at certain times of the year.

The banca and the net require an investment of from 1,000 to 3,000 pesos.

Sapiao or cabiao.—This round haul seine is made of cotton twine, and is used also in pelagic fishing with the aid of light. The schools of such species as the anchovies, herrings, and mackerels are first attracted by powerful lights and then surrounded by the net concentrating the catch in the landing bag, whence they are brailed out by means of dip nets. This method of fishing is described in detail in an earlier paper published in this Journal.³

Other gear of less commercial importance and popularly used in other parts of the Philippines in the same manner as they are employed in Ragay Gulf, and which require no further illucidation, are the *bobo* (fish trap); *quitang* (trawl line); *sakag*, *kolo-kotok*, *salambao* (huge dip nets); *pante* (gill net), and *pukot* or *chinchorro* and *salap* (drag seines).

FISH PRESERVATION

Rapid and adequate transportation coupled with ready facilities for icing tend to make possible the marketing of the bulk of the catch in a fresh condition in big centers, such as Naga, Lucena, and Manila, and consequently a very limited part of the hauls is converted into the preserved product for sale. Only the pelagic fishes caught seasonally in great quantities, such as the herrings, sardines, and mackerels, pass through the salting and smoking sheds. A limited quantity of the beam-trawl catches is also salted and dried. Thus three methods of preservation are commonly observed here—refrigeration, dry salting, and smoking.

Refrigeration.—Refrigeration is only a temporary method of preservation, serving to check the process of putrefaction by

³ Philip. Journ. Sci. 54 (1934) 372-377.

lowering the temperature by means of ice, and thus to prevent the action of bacteria on the flesh of the fishes. This method is never resorted to by the fishermen that use small bancas, but is rather confined to those employing motor boats in their business.

Ice is supplied by the San Miguel Brewery of Manila in special cars of the Mania Railroad Company, by The Calauag Ice Plant, and by the Camarines Sur Industry Company at Magarao, Camarines Sur Province.

The beam trawls take ice blocks to the fishing ground, and the catch is iced on board the vessel in fish trays after every haul. Upon arrival at the home port the catch is transferred to fish boxes preparatory for shipment to Manila. In these boxes a layer of crushed ice alternates with a layer of fish. This method is what is known as direct icing.

In Pasacao the catch of the sibid-sibid fishermen of Burias Island is collected by a motor boat. It consists of the large-sized species commonly seen in the fresh-fish markets of Manila. Upon arrival at the landing proper, these are temporarily placed in a big wooden ice box, whence they are transferred or packed in regular fish boxes in which they are shipped to Manila by rail at the Pamplona Station of the Bicol line. In Pasacao direct icing is also employed, a layer of ice alternating with a layer of fish.

Dry salting.—The procedure of dry salting followed is the same as that practiced in Manila and other fishing centers in the Philippines. The catch is washed first in sea water, then in fresh water, then immersed in brining tanks (with saturated salt solution) for about 4 hours, again washed in fresh water to remove excess salt, and dried thoroughly in the sun. The product is finally packed in bamboo fish baskets and shipped to Manila by rail.

The following is the cost of producing one *canastro* containing about 3,000 individual dry-salted herrings.

	Pesos.
Raw fish	8.00
Salt	0.30
Arranging in fish trays for drying	0.30
Cargador	0.20
Total	8.80

Smoking.—Because of the fact that those engaged in the preservation of the catch are mostly immigrants from Manila,

the preservation methods, including the making of tinapa or smoked products, are identical with those used in Manila.

The herrings, which are the fishes generally smoked, are first washed in sea water. They are then rinsed in fresh water and immersed in brining tanks or vats containing a very concentrated solution of salt, the strength of which is determined by touch. Simultaneously one liter of salt is added to one *kawa* of water and brought to a boil; the fish in the brining tanks are arranged in fish trays and thus immersed in the boiling salt solution until the eyes bulge out and a portion of the tail breaks. The accumulation of fish eyes at the bottom of this basin denotes a well-salted product. The fish are then allowed to drain, and when cooled are placed in the ovens where they are smoked until they turn brown. This operation generally requires two refuelings.

Often the brined herrings are simply cooked and shipped to smoke houses in Manila where they undergo final smoking.

The following items enter into the conversion of 3,000 herrings into the smoked product (tinapa) :

	Pesos.
Raw fish	8.00
Salt	0.30
Arranging in trays	0.30
Sawdust	0.20
Firewood	0.50
Cargador	0.20
 Total	 9.50

CONCLUSIONS AND RECOMMENDATIONS

1. The center of the fishing industry in Ragay Gulf for Tayabas Province is Barrio Aloneros, Guinayañgan, and Pasacao for Camarines Sur Province.

2. The fishing season in the gulf occurs throughout the year, the eastern coast being rich and favorable during the northeast monsoon and trade winds and the western during the southwest monsoon.

3. While the coasts around Pasacao and Burias Island are rich fishing grounds for coral-reef species, the eastern coast and the head of the gulf are hiding places of pelagic species, such as the herrings and mackerels. Trawling is carried on only in the neighborhood of the head of the gulf around the municipal jurisdiction of Guinayañgan.

4. From the point of view of proper utilization and conservation of the fishery of this region, fishing with light and the catching of enormous quantities of small fishes are problems that need immediate attention.

5. Dynamite fishing and the catching of fish by the employment of poison (bayate) must be strictly dealt with.

6. A more sanitary supervision over the preparation of *tuyô* and *tinapa* is essential. The use of a more refined salt that will not greatly increase the cost of production is needed.

7. Aside from the ground species that compose the bulk of the beam-trawl catch, herrings (tamban, tunsoy, and laolao), mackerels (hasa-hasâ and lumahan), anchovies, hardtails, bag-eyes, and bonitos and tunas are the most important species caught in the gulf.

8. More attention and care must be exercised in the handling of the catch before they are refrigerated, dried, or smoked, so as to maintain as much as possible the original flavor of the fresh fish.

ILLUSTRATIONS

PLATE 1

- FIG. 1. M. S. Koshindo Maru docking at Old Aloneros to deliver the catch.
2. Icing and packing beam-trawl catches at Old Aloneros for shipment to Manila by rail.
3. Kubkub catches being landed at Catabañgan, Camarines Sur Province, for marketing in the fresh state.
4. The Manila Railroad terminal at Old Aloneros, whence catches in Ragay Gulf are shipped to Manila.
5. Large fishes, hauls of sibid-sibid fishermen from Burias, being packed in ice at Pasacao for shipment to Manila via Pamplona.
6. Two largarete outfits anchored at Manglayô, Guinayañgan.
7. A fleet of largarete outfits being towed to the fishing grounds.

PLATE 2

- FIG. 1. A largarete outfit ready to start for the fishing grounds.
2. Unloading herring catches of largarete to motor boat at Peris Bay.
3. Smoking kilns at Mr. Long Hai's shed.
4. Largarete fleet towed from the fishing ground.
5. Drying platforms and smoking shed of Mr. Kong Long Hai at Old Aloneros, Guinayañgan.
6. Smoke house and drying platforms of Mr. Mariano Santiago at Manglayô, Guinayañgan.

PLATE 3

- FIG. 1. Sorting fish for salting and drying at Mr. Kong Long Hai's shed at Old Aloneros.
2. Concrete brining tank in Mr. Santiago's shed at Manglayô, Guinayañgan.
3. Smoking kilns at Mr. Santiago's shed.
4. Cooking brined herring at Mr. Santiago's shed at Manglayo, Guinayañgan.
5. A row of cooking kettles at Mr. Kong Long Hai's shed in Old Aloneros.
6. Cooking kettles at Mr. Santiago's shed in Manglayo.
7. Barrio Manglayo, Guinayañgan, home of largarete fishermen.
8. A row of smoking sheds and drying platforms at Manglayô, Guinayañgan.

TEXT FIGURES

- FIG. 1. Largarete in operation.
2. Detail of stretching and retrieving device of largarete.
3. Quinavite fish corral.
4. Boholano fish corral.
5. Pangalato fish corral.
6. Natural or ordinario fish corral.
7. Pahubas.
8. Kubkub in operation.

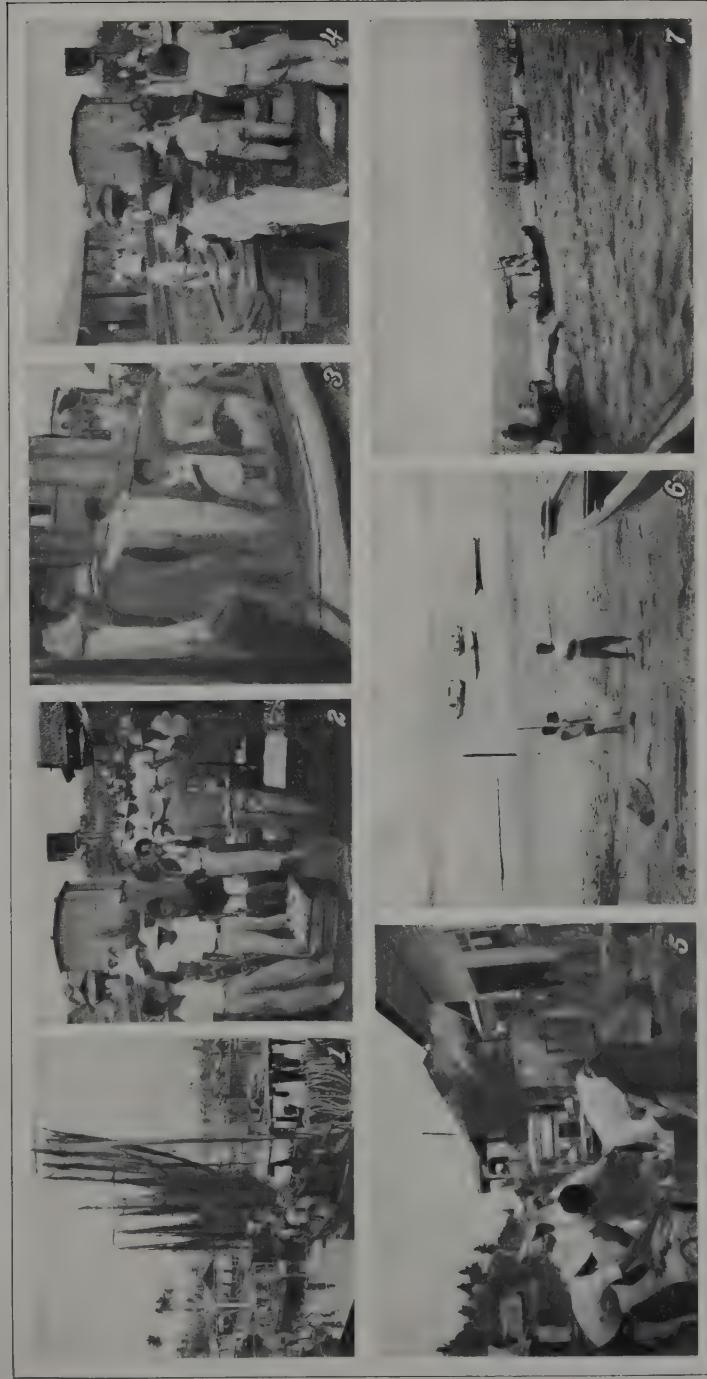






PLATE 3.

NOTE ON THE INVERTEBRATE FAUNA OF SAKUL ISLAND LAGOON, ZAMBOANGA

By JOSÉ S. DOMANTAY

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Sakul is a small island located southeast of the peninsula of Zamboanga, longitude $122^{\circ} 15'$ and latitude $6^{\circ} 55'$. The southwestern two-thirds of the Island is covered with mangrove swamps. The northeastern third is hilly, with a plain along the coast planted with coconuts. Across the mangrove swamps is a narrow canal which is navigable by small motor boats during high tide, and thus serves as a short cut from the eastern side of the island to the mainland of Zamboanga. At the southern end of the northeastern third of the island is a small lagoon, known among the residents of the place as Moro Inlet, with an area of less than two hectares. The lagoon is well protected from the open sea by a high sandy coral bar with a narrow passage extending into the inward end of the lagoon, which is navigable during high tide. The lagoon serves as anchorage and shelter for Moro vintas during bad weather, although the Moros living in vintas are usually found in this place even during calm days. It is said that at times as many as one hundred of these vintas are found in the lagoon.

The lagoon is almost rectangular, with a slight irregularity in its coastline. The coastline is generally sandy, with a small portion covered by rock boulders. The bottom of the lagoon is sandy, with eel grasses, and the banks of the passage are rocky. A small very shallow creek empties into this lagoon. On the end opposite to that of the narrow passage is a mangrove swamp usually exposed at low tide. The deepest part of the gulf at low water is only a meter.

Few fishes, mostly anchovies and fry of other fishes, are found in this lagoon. Among the eel grasses and along the sandy shore are numerous jellyfishes of the genus *Cassiopea*, synaptids of the species *Opheodesoma spectabilis* Fisher var. *puerto-galeræ* Domantay, a few echinoids of the species *Diadema setosum* (Leske), and asteroids of the species *Oreaster nodosus*

(Linnæus). Among the rock boulders are synaptids of the species *Synapta maculata* (Chamisso and Eysenhardt), echinoids (*Diadema setosum*), ophiuroids of the species *Ophiocoma scolopendrina* (Lamarck), and *O. erinaceus* Müller and Troschel, holothurians of the species *Holothuria pulla* (Selenka), and a few sponges of the genera *Euspongia* and *Siphonochalina*. The crustaceans are represented by hermit crabs of the genus *Pagurus* and a few ordinary crabs of the genus *Neptunus*. Along the shores are numerous empty shells of razor clams of the species *Pedalion isognomum* Linnæus which may have been collected from the sea outside the lagoon. Several species of *Cyprea* and other shells are occasionally found along the shores. The predominant forms in the lagoon are *Diadema setosum*, *Synapta maculata*, *Opheodesoma spectabilis* var. *puerto-galeræ*, and *Cassiopea*. A more thorough survey of this lagoon may reveal more forms of marine life. Along the eastern shoal of Sakul Island are numerous starfishes (*Oreaster nodosus*) which can be collected by the thousands.

THE LITTORAL ASTEROIDEA OF PORT GALERA BAY AND ADJACENT WATERS¹

By JOSÉ S. DOMANTAY and HILARIO A. ROXAS

Of the Fish and Game Administration, Bureau of Science, Manila

SEVENTEEN PLATES

The starfishes collected by the 1912 joint expedition of the University of the Philippines and the Bureau of Science from Port Galera Bay, Mindoro, and adjacent waters, and deposited in the Department of Zoölogy, University of the Philippines, formed the nucleus of a starfish collection which was left untouched till 1924. Every summer since 1924 the writers have had occasion to collect additional specimens from the same region. In the absence of facilities for collecting them, deep-sea forms are not available and therefore not included in this work. Since new specimens are added to the collection almost every year, it is believed that later examples of additional forms may be encountered in this region, especially when collecting is done throughout the year.

Not a single specimen from Port Galera Bay was included in the collection described by Fisher in 1919. A few from this locality were reported, however, by H. L. Clark in 1921. The present manuscript, which embodies the result of asteroid studies started in 1924, gives an idea of the extent of the littoral starfish fauna of Port Galera Bay. Fifty species, belonging to nineteen genera and ten families, are briefly described here and illustrated with photographs. Keys to species are provided in the case of genera represented by several species.

LITTORAL ASTEROIDEA OF PORT GALERA BAY AND ADJACENT WATERS

Order Phanerozonia Sladen.

Family Astropectinidæ Gray.

1. *Astropecten polyacanthus* Müller and Troschel.
2. *Astropecten phragmorus* Döderlein.

Family Luidiidæ Verrill.

3. *Luidia maculata* Müller and Troschel.

¹ This work was started while the writers were with the Department of Zoölogy, University of the Philippines.

Family Archasteridæ Viguer.

4. *Archaster typicus* Müller and Troschel.
5. *Archaster angulatus* Müller and Troschel.

Family Gonasteridæ Forbes.

6. *Hipasteria philippinensis* sp. nov.
7. *Stellaster incei* Gray.

Family Oreasteridæ Fisher.

8. *Oreaster nodosus* (Linnaeus).
9. *Oreaster nodosus* var. *honduræ* var. nov.
10. *Oreaster alveolatus* (Perrier).
11. *Oreaster doederleini* Goto.

Family Pentacerotidæ Gray.

12. *Pentaceropsis tyloderma* Fisher.
13. *Pentaceropsis tyloderma* var. *mindorensis* var. nov.
14. *Pentaceropsis obtusatus* (Bory de Saint Vincent).
15. *Culcita novæ-guineæ* Müller and Troschel.
16. *Culcita novæ-guineæ* var. *grex* Goto.
17. *Culcita novæ-guineæ* var. *plana* Goto.
18. *Culcita novæ-guineæ* var. *typica* Goto.
19. *Culcita novæ-guineæ* var. *acutispinosa* Goto.
20. *Halityle regularis* Fisher.
21. *Choriaster granulatus* Lutken.

Family Gymnasteriidæ Perrier.

22. *Gymnasteria carinifera* (Lamarck).

Family Linckiidae Perrier.

23. *Fromia indica* Perrier.
24. *Fromia pacifica* Clark.
25. *Fromia elegans* Clark.
26. *Fromia eusticha* Fisher.
27. *Fromia japonica* Perrier.
28. *Leiaster speciosus* von Martens.
29. *Linckia lavigata* (Linnaeus).
30. *Linckia lavigata* var. *honduræ* var. nov.
31. *Linckia multifora* (Lamarck).
32. *Linckia guldbergii* Gray.
33. *Ophidiaster granifer* Lutken.
34. *Ophidiaster squameus* Fisher.
35. *Nardoa variolatus* (Lamarck).
36. *Nardoa squamulosa* Koehler.
37. *Nardoa novæ-caledoniæ* (Perrier).
38. *Nardoa mollis* de Loriol.
39. *Nardoa lemonnieri* Koehler.
40. *Nardoa pauciforis* (von Martens).
41. *Nardoa tuberculata* (Müller and Troschel).
42. *Nardoa frianti* Koehler.

Order Spinulosa Perrier.

Family Asteriinidæ Gray.

43. *Asterina (Patiriella) exigua* (Lamarck).
44. *Asterina coronata euerces* Fisher.
45. *Asterina coronata puerto-galeræ* subsp. nov.

Family Echinasteridæ Verrill.

Subfamily Acanthasterinæ Sladen.

46. *Acanthaster planci* (Linnæus).47. *Acanthaster mauritiensis* de Loriol.

Subfamily Echinasterinæ Viguer.

48. *Echinaster callosus* von Marenzeller.49. *Echinaster luzonicus* (Gray).50. *Echinaster purpureus* Savigny.*Key to the families of littoral Asteroidea of Port Galera Bay.*

*a*¹. Marginal plates usually large and conspicuous; abactinal skeleton of paxilliform plates, or flat, tessellate plates which are smooth or with granules or spines, and either naked or covered with a thick membrane. Pedicellariæ never pedunculate forcipiform, but spiniform, pectinate, valvate, or excavate. Papulæ restricted to abactinal area (except in some Linckiidæ and Asteropidæ) circumscribed by the marginal plates (Order PHANEROZONIA).

*b*¹. Tube feet pointed, without a well-developed flat sucking disc, sometimes with a small pointed knob at tip.

*c*¹. Superomarginal plates never obsolete, though at times small; not replaced by paxillæ; papulæ simple.... ASTROPECTINIDÆ.

*c*². Superomarginal plates aborted and replaced by paxillæ; inferomarginals broad; papulæ compound..... LUIDIDÆ.

*b*². Tube feet with well-developed and prominent sucking discs.

*c*¹. Abactinal plates paxilliform or tabulate; marginal plates opposite, not conspicuously spiny; papulæ not confined to base of ray and adjacent portion of disc and never localized in special papular organs.

*d*¹. Abactinal plates arranged in oblique rows on either side of a conspicuous medioradial series and with special internal imbricating ridges; actinal intermediate plates obsolete or very few, gonads extending far along rays.

ARCHASTERIDÆ.

*d*². Abactinal plates not arranged in definite oblique series, no internal imbricating ridges; actinal interradial areas large, with numerous plates; gonads interradial.

GONIASTERIDÆ.

*c*². Abactinal plates neither tabulate nor paxilliform, but flat, convex, spinous, tubercular, granular or smooth; sometimes overlaid by a thin or thick, smooth or granulous skin; marginal plates with or without robust spines or tubercles.

*d*¹. Disc large; actinal interradial areas extensive; no papulæ on actinal surface.

*e*¹. Marginal plates large, but as a rule inconspicuous, being more or less hidden by granulous skin; abactinal skeleton stellate-reticulate plates, always granulous; papulæ numerous, and in definite areas.

*f*¹. Abactinal plates usually with large conical tubercles or spines; disc usually high.. OREASTERIDÆ.

*f*². Resembling Oreasteridae but without conical tubercles or spines; disc usually not high.

PENTACEROTIDÆ.

*e*³. Marginal plates small, more or less imbricated.

Abactinal skeleton tessellate; plates often irregular and only partially contingent, the whole covered with a thick, leathery skin; abactinal skeleton tessellate or reticulate..... GYMNASTERIDIÆ.

*d*². Disc small, usually with very small actinal interradial areas, if large, with papulae on actinal surface. Marginals small; abactinal skeleton tessellate, arranged irregularly or more or less in regular longitudinal series. Superambulacral plates usually present. Pedicellariae, when present, excavate. Rays usually slender, long, and subcylindrical..... LINCKIIDÆ.

*a*². Marginal plates not usually conspicuously large; abactinal skeleton not composed of true paxilliform plates, nor in the form of a tessellated pavement, but usually more or less reticulate or imbricate. Papulae frequently but not invariably also intermarginal and actinal. Some form of abactinal spinulation always present.

(Order SPINULOSA).

*b*¹. Abactinal skeleton formed of closely imbricating plates bearing a tuft or fan of spinelets. Marginal plates minute. Pedicellariae very rare and never pedunculate or excavate. Papulae distributed throughout the abactinal area. Abactinal plates thick, crescentiform, devoid of internal processes..... ASTERINIDÆ.

*b*². Abactinal skeleton formed of plates disposed in longitudinal and transverse series, or in an irregular network, bearing spinelets; spinelets not disposed in a tuft or fan. Spinelets small, pointed, naked, or covered with a thin skin containing calcareous granulations..... ECHINASTERIDIÆ.

Order PHANEROZONIA Sladen

Marginal plates large and highly developed in the adult. Superomarginals and inferomarginals contingent, with their axes usually in parallel planes. Papulae restricted to abactinal area, circumscribed by superomarginals. Ambulacral plates well spaced, usually broad. Actinostomial ring with adambulacral plates prominent. Pedicellariae valvate, foraminata, or excavate.

Family ASTROPECTINIDÆ Gray

With large marginal plates bearing spines or spiniform papulae. Abactinal skeleton with true columnar paxillæ. Actinal interradial areas small, intermediate plates when present spinous. Adambulacral plates present. Pedicellariae rarely present.

Genus ASTROPECTEN Gray (1840)

ASTROPECTEN POLYACANTHUS Müller and Troschel. Plate 1, figs. 1 to 4; Plate 2, figs. 7 and 8.

Astropecten polyacanthus MÜLLER and TROSCHEL (1842); PERRIER (1876); SLADEN (1879, 1889); BELL (1884b); DE LORIOL (1885); DÖDERLEIN (1888, 1917); FARQUHAR (1898); FISHER (1906, 1919); GOTO (1914); CLARK (1923); MORTENSEN (1933, 1934).

Astropecten hystrix MÜLLER and TROSCHEL (1842).

Astropecten armatus MÜLLER and TROSCHEL (1842).

Astropecten vappa MÜLLER and TROSCHEL (1842).

Astropecten edwardsi VERRILL (1867).

Rather rare and found on sandy-rocky bottom along Gabino and Boaya points. A beautiful starfish, greenish gray on aboral and pinkish red on oral side, especially along ambulacral grooves.

Superomarginal spines upright and prominent, proximally equalling height of plate; second superomarginal without spine; inferomarginals with 3 to 4 large bristling spines, with 28 to 30 superomarginal plates. R, 100 millimeters, r, 18; R = 5r. University of the Philippines, E-684, E-700, E-754, E-801.

ASTROPECTEN PHRAGMORUS Döderlein. Plate 1, figs. 5 and 6; Plate 3, fig. 13.

Astropecten phragmorus DÖDERLEIN (1917); FISHER (1919).

Astropecten acanthifer phragmorus FISHER (1913).

Color pattern varying slightly. Anal region pinkish orange, surrounded by a circular area (pentagonal in some specimens) of purple, speckled with purplish violet; blotches of similar color on proximal third of ray, homogeneous yellowish brown on middle third, more or less homogeneous purple on distal third of ray. Oral side, except proximal two-thirds of tube feet and distal tip, reddish orange.

Superomarginal plates 25, bearing pinkish brown spines, about $1\frac{1}{2}$ as high as plates. Second and third plates devoid of spines. Inferomarginals same in number as superomarginals, with 3 lateral spines of different sizes, the uppermost largest. Furrow spines 3 or 4. R, 60 millimeters; r, 12; R = 5r. Three specimens collected from sandy-grassy region of Honduras shoal. University of the Philippines E-1005, E-1028, E-1029.

Family LUIDIIDÆ Verrill

Superambulacral plates usually present. Inferomarginal plates separated from adambulacral plates by a small intermediate plate throughout ray. Marginal and adambulacral

plates corresponding in length and number. Fasciolar grooves between marginal plates usually well developed; paxillæ typical. Superomarginal plates aborted, represented by a series of paxillæ.

Genus **LUIDIA** Forbes (1839)

LUIDIA MACULATA Müller and Troschel. Plate 4, fig. 19.

Luidia maculata MÜLLER and TROSCHEL (1842); PERRIER (1875); DÖDERLEIN (1888); KOEHLER (1895, 1910); CLARK (1916, 1921); FISHER (1919); MORTENSEN (1934).

The only specimen collected has eight arms banded dark gray and white. Diameter of disc 20 millimeters, diameter of arm 80. R, 90 millimeters; r, 12; R = 7.5r. Exact locality not recorded. University of the Philippines E-737.

Family ARCHASTERIDÆ Viguier

Thick and massive marginal plates bearing spines or spiniform papillæ. Abactinal skeleton with simple spiniform spicules, with pseudopaxillæ, or with true paxillæ. Actinal interradial areas with compressed plates. Pedicellariæ often present. No superambulacral plates.

Genus **ARCHASTER** Müller and Troschel (1840)

ARCHASTER TYPICUS Müller and Troschel. Plate 3, figs. 14 to 18.

Archaster typicus MÜLLER and TROSCHEL (1840); FISHER (1919).
Astropecten stellaris GRAY (1840).
Archaster nicobaricus MOBIUS (1859).

Most common and most numerous starfish found along sandy-muddy shore of Varadero Bay, Small Balatero Cove, and adjacent waters. During low tide many individuals are exposed and seen one over the other, apparently in the act of amplexus. General ground color of abactinal side ranging from grayish brown to dark gray or ash gray mottle with irregular darker areas of no uniform pattern. Irregular alternation of lighter and darker areas along superomarginal plates. Oral surface white, except tube feet, which are greenish white. In some specimens a few inferomarginal plates slightly darker. Individuals with four, six, and seven arms occasionally found. Some specimens with a few stout spines at upper median edge of superomarginal plates, one spine to a plate. Superomarginal plates 30 to 45.

Inferomarginal plates provided with a single prominent lateral flattened spine. Measurement of largest specimen: R,

75 millimeters; r, 15. Average R, 60 millimeters; r, 12; R = 5r. Paxillæ of median radial row distinct with 7 to 12 spinelets, lateral ones with 4 to 5. Lateral paxillæ arranged in distinct rows with their spinelets projecting. University of the Philippines E-616, E-617, E-749, E-785, E-813.

ARCHASTER ANGULATUS Müller and Troschel.

Archaster angulatus MÜLLER and TROSCHEL (1842); DE LORIOL (1885); FISHER (1919).

A rare species, occasionally seen together with *A. typicus*, from which it can be told by the presence of 2 or 3 enlarged squamiform spinelets at outer end of inferomarginal plates. Rays narrower and more slender than in *A. typicus*; superomarginals encroaching conspicuously upon abactinal area.

No signs of superomarginal spines; median radial row of paxillæ very regular, spinelets 12 to 14, more centrally situated paxillæ with 6 to 8, much crowded spinelets obscuring distinct arrangement of paxillæ in rows. University of the Philippines E-887.

Family GONIASTERIDÆ Forbes

Marginal plates thick and massive, disc large, primary apical plates usually conspicuous, abactinal and actinal intermediate plates tessellate; abactinal plates polygonal, circular, or stellate, sometimes united by internal radiating ossicles, or forming a close mesh with numerous secondary intermediate plates; plates bearing a central tabulum, paxilliform in structure, or flat, naked, or covered with granules, or bearing an enlarged spine. Papulæ usually confined to radial areas. Plates obscured by a tough skin of varying thickness, which is superficially smooth, or covered with granules or with granules and pedicellariæ. Tube feet with large sucking discs. Superambulacral ossicles present, rudimentary, or absent. Pedicellariæ foraminatae, excavate, or bivalved.

Genus HIPPASTERIA Gray (1866)

HIPPASTERIA PHILIPPINENSIS sp. nov. Plate 4, figs. 21 and 22.

A small species, only two examples so far collected from among rocks near Gabino point, Varadero Bay. One specimen has the abactinal side a combination of dirty green on disc and rays and yellowish brown on interbrachial regions. Oral side yellowish brown speckled with light green. The other specimen pinkish red on centrodorsal region around anal opening and along rays,

and dark green on interbrachial region and surrounding circular pinkish red around anal opening. On oral side pinkish red confined to rays and dark green to interambulacral and centro-oral disc, giving a flowerlike appearance with five petals. After preservation and drying one specimen turned reddish brown, the green practically all disappearing.

Body flat and slightly pentaradiate, with marginal border of disc almost straight and arms triangular. Oral surface as a whole nearly flat. Abactinal plates circular and markedly separated by narrow poriferous areas. Plates covered with numerous fine granules. Centrodorsal plates surrounding the 6 or 7 anal plates each with one large conspicuous rounded granule. Some plates of disc and those bordering superomarginal plates with similar large granules besides the finer ones. Each superomarginal with 2 to 6 similar granules. Abactinal plates of interbrachial region as well as those along superomarginals with 1 or more valvate pedicellariæ; a few specimens with 2 and some with none. Supero- and inferomarginals devoid of pedicellariæ. Superomarginals very large, corresponding in level with inferomarginals, which they closely resemble.

Actinal plates well marked and not separated by a poriferous region, with more or less of a pavement arrangement, each pavement composed of hexagonal tiles covered by numerous fine granules with 1 or 2 valvate pedicellariæ. Adambulacral spines in two series with 5 furrow spines. Mouth plates somewhat large but not very conspicuous. Each plate has the form of a scalene triangle with 18 furrow spines. At outer angle next to angular furrow spines 4 conical spines arranged in series. Next to this series another one with 10 granular spines. Rest of mouth plates covered with granules. R , 18 millimeters; r , 11; $R = 1.63r$.

Type specimen (University of the Philippines, E-953) deposited in the Philippine National Museum, Bureau of Science.

Genus STELLASTER Gray, 1847

STELLASTER INCEI GRAY. Plate 5, fig. 30.

Stellaster incei GRAY (1847); SLADEN (1889); DÖDERLEIN (1896); KOEHLER (1910); BROWN (1910); SIMPSON and BROWN (1910); H. L. CLARK (1916, 1921).

Stellaster belcheri GRAY (1847); SLADEN (1889).

Stellaster gracilis MOBIUS (1859).

Apparently rare. Specimens in collection collected by members of first expedition in 1912 from Puerto Galera Bay. Not a single specimen has been encountered by the writers since then.

Our specimens agree in all respects with the description and illustration of Fisher (1919). University of the Philippines E-783.

Family OREASTERIDÆ Fisher

Tergal ossicles always reticulated with more or less extensive pore areas. Interambulacral plates never intercalated, the investing granules not projecting from their side so as to separate ossicles from one another, nor limited to base, but always passing some way up the sides of spines or tubercles, when such are developed.

Genus OREASTER Müller and Troschel (1842)

OREASTER NODOSUS (Linnæus). Plate 5, fig. 28; Plate 15, fig. 90.

Asterias nodosa LINNÆUS (1758).

Pentaceros turritus PERRIER (1875).

Oreaster nodosus BELL (1884a); CLARK (1908, 1921); FISHER (1919).

Abactinal surface varying between dirty green, greenish brown, brownish orange, orange, brownish red, and reddish orange. In some specimens interbrachial region lighter, usually brownish or grayish. Tubercles varying from dark green to greenish violet. In some specimens distal third of ray greenish violet. Oral side diverse in color like aboral side. Inferomarginal plates with small actinal plates of various shades of green.

Dorsal simple or branched tubercles on disc 5; those of ray varying in number as well as in form with size and age. Two abnormal specimens with 4 rays only, one having 3 dorsal tubercles with a sign of injury on the bivium where the madreporite is located, hence no madreporite visible.

Most specimens were taken from Honduras muddy-grassy shoal of Varadero Bay, from wide shallow grassy shoal of Calapan near the wharf, and from the sandy-muddy grassy shoal of Carot, Lingayen Gulf. They are apparently inhabitants of sandy-muddy-grassy shoals and not of coral reefs. University of the Philippines E-732, E-733, E-752, E-837, E-838, E-844, E-886.

OREASTER NODOSUS var. HONDURÆ var. nov. Plate 14, fig. 82.

Aboral side together with base of tubercles generally green. Some abactinal and superomarginal plates grayish brown with tips of tubercles light orange. Dorsal tubercles 4, with 8 or 9 carinal tubercles. Proximal first tubercles with a lateral tubercle on each side. In interbrachial arch above superomarginals 1 to 4 small tubercles; along sides of ray above superomar-

ginals 2 to 5 small tubercles; distal superomarginals well developed and conspicuous, with 1 to 2 low tubercles; all tubercles capped with big conspicuous teatlike granules surrounded by smaller ones. Abactinal plates and poriferous areas (papulae) arranged in longitudinal series on each ray, 7 rows of plates and 8 rows of papulae; abactinal plates on disc irregular, and papular areas conspicuously bigger than plates. Supero- and inferomarginal plates 18; series of adambulacral armatures 2, and furrow spines 6. Valvate sessile pedicellariae one on each of smaller plates without tubercles; madreporite elongated. Collected from Hondua grassy shoal, Varadero Bay.

The type specimen (University of the Philippines E-1044) is deposited in the Philippine National Museum, Bureau of Science.

OREASTER ALVEOLATUS (Perrier). Plate 6, figs. 31 and 32.

Pentaceros alveolatus PERRIER (1875); KOEHLER (1910).

Oreaster alveolatus BELL (1884a); FISHER (1919).

Habitat similar to that of *O. nodosus*, from which this species differs in the presence of prominent distal superomarginal and inferomarginal spines and of very prominent abactinal spines which are conical, heavy, and granular with a prominent bare conical sharp tip arranged radially, interradially, and usually within the apical area. Specimens obtained from shallow grassy shoal of Calapan, a few small ones from Hondua shoal, Varadero Bay. University of the Philippines E-603, E-734, E-759, E-761.

OREASTER DOEDERLEINI Goto. Plate 15, fig. 88.

Oreaster doederleini GOTO (1914).

The unique specimen was collected several years ago from the neighborhood of Port Galera Bay. Exact location not recorded. Body depressed, slightly concave below and convex above. Arm tips upturned. Interbrachial arcs entirely open. Superomarginal plates 21. Inferomarginals confined to actinal side and larger than superomarginals. Abactinal plates arranged in rows parallel with lateral borders of body. Distinct carinal series of plates in each arm raised into tubercles bearing a teat-like spine at tip. Madreporite pear-shaped, comparatively large but not very conspicuous, with very fine convoluted furrows on the surface and located well out of central pentagon formed by apical tubercles. R, 150 millimeters; r, 55. University of the Philippines E-857 (K-300).

Family PENTACEROTIDÆ Gray

With unequally developed marginal plates, the superior series frequently masked or hidden in membrane. Abactinal skeleton reticulate. Plates with large isolated tubercles or spinelets, or granulose, or covered with membrane. Actinal interradial areas with large pavementlike plates, which bear granules of unequal size.

Genus PENTACEROPSIS Sladen (1889)

PENTACEROPSIS TYLODERMA Fisher. Plate 5, figs. 25 and 26; Plate 14, figs. 78 and 79.

Pentaceropsis tyloderma FISHER (1913, 1919).

Philippine specimens collected from wide shallow grassy flat of Honduras, Varadero Bay, and of Calapan, Mindoro. Abactinal surface with general ground color of grayish brown confined to the granular plates, tip of rays blackish brown. Like in *Oreaster*, the color varies in different specimens. Actinal side light orange with adambulacral and ambulacral spines yellowish. Habitat the same as that of *O. nodosus* and *O. alveolatus*.

Series of subambulacral spines 1; no inferomarginal tubercles, except on the first few plates; distal superomarginals less prominent, without smooth tubercles; papular granules very much smaller than those of convex plates. Disc inflated, rays convex, much lower than disc; interbrachial arcs well rounded; rays broad, tapering toward rounded end. One series of subambulacral spines with 8 furrow spinelets, large triangular superomarginal plates, and apical tubercles; convex abactinal plates large and not very close together, medioradial series distinct and proximal plate large and conical. Average measurement: R, 70 millimeters; r, 35; R = 2r. University of the Philippines E-606, E-699, E-738, E-836, E-950, E-1038.

PENTACEROPSIS TYLODERMA var. MINDORENSIS var. nov. Plate 5, fig. 27.

Collected from Honduras, Varadero Bay. Aboral disc and rays light green and purplish, the former confined to poriferous area and the latter to plates. Oral side light orange. Ten dorsoradial plates of disc with medium-sized tubercles, the rest together with those of rays, same as typical species. Tips of rays more pointed.

Supero- and inferomarginal plates 12; two proximal and three distal inferomarginals with medium-sized tubercles; series of

adambulacral armatures 2, furrow spines 5 to 6. R, 35 millimeters; r, 20; R = 1.75r.

Type specimen (University of the Philippines E-1034) deposited in the National Museum, Bureau of Science.

PENTACEROPSIS OBTUSATUS (Bory de Saint Vincent).

Asterias obtusatus BORY DE SAINT VINCENT (1827).

Oreaster obtusatus MÜLLER and TROSCHEL (1842).

Pentaceros obtusatus PERRIER (1875).

Pentaceropsis obtusatus SLADEN (1889).

Collected from Honduras, Varadero Bay. Aboral disc dark green, the rest, together with rays, middle superomarginals, and tip of rays gray, speckled with darker gray or grayish black in some carinal plates. Oral side yellow or light orange.

Aboral plates covered with granules, some of these with teat-like granules at center and arranged in radial series, five rows from interbrachial to proximal half of ray and three rows from middle to tip of ray. Papulae likewise arranged in series, each with 2 or 3 pores. Series of adambulacral armature 2, furrow spines 5, the 2 lateral spines very short. Distal superomarginals and inferomarginals conspicuous, the latter bearing tubercles. University of the Philippines E-1036.

Genus CULCITA Agassiz (1835)

Body pentagonal or roundish. Poriferous areas separate or more or less continuous, a marginal zone of variable width free from papulae. Nonporiferous areas sometimes forming patches of variable sizes in midst of poriferous areas, sometimes with spines or tubercles as far as ventral margin of body. Ventral surface finely granulated and with coarse pearl-shaped, flattened or rod-shaped granules. Inner adambulacral spines usually 5, at most 7.

Key to the varieties of Culcita novæ-guineæ in Port Galera Bay.

a¹. Poriferous areas small.

b¹. Poriferous areas with spines.

c¹. Dorsal tubercles all spiniform. Spines of poriferous areas mostly smaller than those of nonporiferous area; coarse granules of ventral side sometimes separated into groups by intervening fine granulation..... *C. novæ-guineæ*.

c². Poriferous areas round and covered with small spines entirely separated from one another by a continuous network of wide nonporiferous areas free from spines; coarse granulation of ventral side very weakly developed.

C. novæ-guineæ var. *grex*.

b². Poriferous areas free from spines, small, roundish, separated by well-developed network of nonporiferous area.

C. novæ-guineæ var. *plana*.

a². Poriferous areas large, prominent.

b¹. Poriferous areas 3- to 6-sided, separated by rows of large spines and large nonporiferous patches..... *C. novæ-guineæ* var. *typica*.

b². Poriferous areas continuous, with only small nonporiferous patches between; dorsal side uniformly covered with numerous coarse spines *C. novæ-guineæ* var. *acutispinosa*.

CULCITA NOVÆ-GUINEÆ Müller and Troschel. Plate 16, figs. 92 and 93.

Goniaster sebæ GRAY (1840).

Goniodiscus sebæ MÜLLER and TROSCHEL (1842).

Calcita novæ-guineæ MÜLLER and TROSCHEL (1842); DÖDERLEIN (1896); GOTO (1914); FISHER (1919).

Calcita pulverulenta PERRIER (1869).

The unique specimen was obtained from corals of northwest Channel of Port Galera Bay. Poriferous areas with spines mostly smaller than those of nonporiferous areas. Coarse granules of ventral side segregated into groups by intervening fine granulation. Young specimen 85 millimeters in diameter and 40 thick at the center. R, 50 millimeters; r, 45. University of the Philippines E-849.

CULCITA NOVÆ-GUINEÆ var. **GREX** Goto.

Calcita grex MÜLLER and TROSCHEL (1840).

Calcita novæ-guineæ var. *grex* GOTO (1914).

Color ranges from yellow to purplish violet, the former more predominant. Two colors intergrade in some poriferous areas. Isolated conspicuous white truncated pedicellariæ present in some papulae. Actinal side generally brownish yellow, lighter at center and darker at periphery with coarse granules. Adam-bulacratal spines and furrow spines range from yellowish brown to purplish orange outward to tip of ray.

Nonporiferous areas of abactinal side continuous, well spaced, generally deep green. Poriferous areas circular, discontinuous, covered with spines. R, 120 millimeters; r, 110; R = 1.09r; diameter, 220; thickness, 65. One specimen (University of the Philippines E-926) collected from Northwest Channel among coral reefs.

CULCITA NOVÆ-GUINEÆ var. **PLANA** Goto. Plate 7, figs. 35 and 36; Plate 8, fig. 89; Plate 16, fig. 98.

Calcita plana HARTLAUB (1892).

Calcita novæ-guineæ var. *plana* GOTO (1914).

Calcita novæ-guineæ *plana* FISHER (1919).

Four specimens collected together with *Calcita novæ-guineæ* var. *typica* from coral reefs of Port Galera Bay. Aboral side a combination of deep green, yellow, and purplish violet.

Poriferous areas small, roundish, and separated by a well-developed network of nonporiferous areas almost free from spines. Papular areas near margin granular and slightly spinous. Non-poriferous (interpapular) areas generally deep green, sometimes with yellow spots, usually plain and finely granular. Marginal region of oral side with color combination similar to that of aboral, with larger and distinctly spinous papular areas. Main part of oral side yellowish green, speckled with yellow and purplish granules. Ambulacral, adambulacral, and furrow spines reddish orange, darker distally than proximally; tube feet purplish. Furrow spines 3 to 7, increasing in number proximally. Four specimens each 125 millimeters in diameter, 60 thick; 200 in diameter, 85 thick; 230 in diameter, 75 thick; and 220 in diameter, 65 thick, respectively. Last two obtained from first coral-reef shoal (first plateau) and from western side of Northwest Channel.

The largest specimen has the following measurements: R, 140 millimeters; r, 130. University of the Philippines E-848, E-850 (K-29), E-895, E-926.

CULCITA NOVÆ-GUINEÆ var. TYPICA Goto. Plate 15, figs. 84 and 85; Plate 16, figs. 96 and 97.

Culcita novæ-guineæ var. *typica* Goto (1914).

The most common variety of *C. novæ-guineæ*, mostly encountered in the first coral reef shoal of Port Galera Bay and in Northwest Channel.

Poriferous areas large and 3- to 6-sided, merging into one another, separated at places by rows of large granular spines of nonporiferous areas. Spines of nonporiferous areas more prominent and larger than those of poriferous areas. Tubercles on actinal surface crowded and more or less compact at middle of interambulacral area. Average, 200 millimeters in diameter and 90 thick. University of the Philippines E-739 (K-28), E-840, E-841, E-851 (K-31), E-852 (K-32), E-853, E-854 (K-27), E-855 (K-30).

CULCITA NOVÆ-GUINEÆ var. ACUTISPINOSA Goto. Plate 7, figs. 37 and 38; Plate 8, figs. 39 and 40; Plate 14, fig. 75.

Culcita acutispinosa BELL (1883).

Culcita novæ-guineæ var. *acutispinosa* Goto (1914).

United papular areas markedly spinous, yellow, deep orange, or greenish brown. Yellow confined mostly to distal sides of indistinct ray, although sparsely visible on disc. Finely granular interpapular areas dark green. Oral side greenish yellow,

speckled with green and brown confined to coarse granules. Adambulacral spines and tips of furrow spines yellowish orange to deep purple outward to tip of rays. Newly preserved specimens deep bluish violet.

Poriferous or papular areas uniformly covered with numerous coarse spines and connected by small nonporiferous patches. Furrow spines 4 to 6. One specimen 125 millimeters in diameter, 60 thick; two 230 in diameter, 65 thick; one 180 in diameter, 80 thick. In large specimens R , 120 millimeters; r , 110; $R = 1.092r$. Collected from the western side of Northwest Channel and from the second coral reef shoal of Port Galera Bay. University of the Philippines E-849, E-914, and E-1050.

Genus HALITYLE Fisher, 1913

HALITYLE REGULARIS Fisher. Plate 14, fig. 76 and 77.

Halityle regularis FISHER (1913, 1919).

Apparently a deep-sea form. The unique specimen was obtained from a fish trap in North Channel, Port Galera Bay, at a depth of about 10 fathoms, among corals.

Marginal and inferomarginal plates well-defined; no tubercles or spines on abactinal and actinal plates; abactinal plates numerous, forming very regular triangular papular areas arranged in regular series. Abactinal surface finely granular, with 2-jawed granuliform pedicellariæ. Actinal plates sharply marked off by sutural grooves and covered with a close mosaic of unequal, smooth, very compact granules. Adambulacral tubercles 2 to 3, large; compact, perpendicular furrow comb with 8 to 11 spinelets. R , 125 millimeters, r , 90; $R = 1.4r$. University of the Philippines E-842.

Genus CHORIASTER Lutken (1869)

CHORIASTER GRANULATUS Lutken. Plate 15, figs. 86 and 87.

Choriaster granulatus LUTKEN (1871); GOTO (1914); FISHER (1919).

Poriferous areas as in *Culcita* confined to abactinal surface, irregular in shape, arranged in a double series of two in each arm up to distal third only, separated by fine, uniform compact granules; also found in interbrachial region of abactinal surface. Madreporite somewhat concave, well exposed and elliptical in outline, covered with irregularly radiating fine grooves and located midway between center of disc and margin.

In preserved specimens, poriferous areas dark brown, nonporiferous pinkish brown. Unique specimen (University of the

Philippines E-856) taken from North Channel, Port Galera Bay. R, 120 millimeters; r, 60; $R = 2r$.

Family GYMNASTERIIDÆ Perrier

Genus GYMNASTERIA Gray (1840)

GYMNASTERIA CARINIFERA (Lamarck). Plate 8, figs. 43 and 44; Plate 16, figs. 94 and 95.

Asterias carinifera Lamarck (1816).

Asterope carinifera Müller and Troschel (1840); Clark (1921).

Asteropsis carinifera Müller and Troschel (1842).

Gymnasteria spinosa Gray (1840).

Gymnasteria inernis Gray (1840).

Gymnasteria biserata von Martens (1866).

Gymnasteria carinifera von Martens (1866); Sladen (1889); Goto (1914).

Apparently rare, only three specimens having been collected, two from corals of Port Galera Bay and one from Cebu. The color agrees exactly with the description of Clark (1921). Skeletal plates covered with humid leathery membrane. Each superomarginal plate bears on outer border a stout, short conical spine projecting obliquely outwards, so that the sides of arms are somewhat serrated. University of the Philippines E-714, E-735, E-736.

Family LINCKIIDÆ Perrier

Marginal plates comparatively well-developed, always contiguous. Disc small, rays long and cylindrical. Abactinal skeleton tessellate. Superambulacral plates usually present, except in *Fromia*. Pedicellariae, if present, excavate or foraminous. Abactinal plates without internal supplementary plates, not forming paxilliform tabula. Abactinal and marginal plates granulose, not bearing spines.

Genus FROMIA Gray (1840)

Key to the species of Fromia.

a'. Superomarginal plates decreasing in size distally with a fair degree of uniformity, not conspicuously swollen. Second series of actinolateral plates well developed, extending more than half the length of ray; series of actinal papulae at base of ray 2, rarely 3.

b'. Rays short, wide. Abactinal surface of each ray covered by about 3 irregular series of large, somewhat swollen plates mingled with much smaller ones; rays 5; $R = 3.5r$ *F. indica*.

b''. Rays long, narrow.

c'. No actinal pedicellariae.

d'. Abactinal surface covered with a uniform coat of fine granules; furrow spinelets 2 or 3; $R = 5r$.

F. pacifica.

*d*². Abactinal granulation coarse, granules of each plate forming a distinct group, central granules same as those of margin; furrow spinelets 2; R = 4.5r.

F. elegans.

*c*². Abundant actinal pedicellariæ; R = 4.5r..... *F. eusticha*.

*a*². Large and small superomarginal plates regularly alternate. Abactinal plates irregularly arranged in series, furrow spinelets 3; R = 4r.

F. japonica.

FROMIA INDICA Perrier.

Scytaster indicus PERRIER (1869).

Fromia indica PERRIER (1875); KOEHLER (1910); CLARK (1921).

Disc and rays flat, with numerous small abactinal plates and few large ones in about 7 or 8 irregular longitudinal series on each ray. Actinal surface with stout spinelets grouped together forming low paxillæ. In some rays supero- and inferomarginals irregular. Rays short but pointed. Series of ambulacral armatures 3, furrow spinelets 2. R, 35 millimeters; r, 10, R = 3.5r. University of the Philippines E-1046.

FROMIA PACIFICA Clark.

Fromia pacifica CLARK (1921).

Superomarginal plates decreasing in size distally, with a fair degree of uniformity and not conspicuously swollen. Abactinal plates small and numerous, about 7 irregular longitudinal series on each ray. Abactinal plates covered with a uniform coat of fine granules. Plates of actinal surface covered with stout spinelets. Series of actinolateral plates 3 proximally, the second extending up to middle of ray and the third becoming rudimentary. Furrow spinelets 2 or 3. Rays tapering gradually and becoming slender distally. R, 50 millimeters; r, 10; R = 5r. University of the Philippines E-612.

FROMIA ELEGANS Clark. Plate 9, figs. 47 and 48; Plate 10, figs. 51 and 52.

Fromia elegans CLARK (1921).

A small starfish found among corals in Port Galera Bay and other places. Most common species of *Fromia* found at station. Body brick red with abactinal plates light brick red. Ambulacral, adambulacral, and furrow spines together with paxillæ on oral side uniformly brick red.

Abactinal granulation coarse; granules of each plate forming a distinct group with central granules, same in size as those of margin, furrow spinelets 2. R, 50 millimeters; r, 11; R = 4.5r. University of the Philippines E-600, E-601, E-611, E-892, E-773 (K-13).

FROMIA EUSTICHA Fisher. Plate 9, figs. 49 and 50.

Fromia eusticha FISHER (1913, 1919).

Long, slender, and evenly tapering rays with very regularly arranged abactinal plates in series. Marginal plates very regular. Superomarginal plates 18, encroaching conspicuously upon abactinal surface. Inferomarginals 20. Furrow spines 3 on proximal half of ray and usually 2 on distal half. Abundant actinal pedicellariæ with circular madreporite. R, 45 millimeters; r, 10; breadth of ray at base, 10; R = 4.5r. University of the Philippines E-771 (K-12).

FROMIA JAPONICA Perrier. Plate 9, figs. 45 and 46.

Fromia major KOEHLER (1895, 1910).

Fromia japonica PERRIER (1881, 1884); DE LORIOL (1891); FISHER (1919).

Superomarginal plates 20, regularly alternating large and small. Granules surrounding papular pores slightly larger than those covering plates. Abactinal plates irregularly arranged in series. Inferomarginal plates 19. Actinal plates arranged in distinct series of four proximally and reduced to one distally. Furrow spines mostly 3. R, 50 millimeters; r, 12; breadth of ray at base, 12; R = 4r. University of the Philippines E-772 (K-10).

Genus LEIASTER Peters (1852)**LEIASTER SPECIOSUS** von Martens. Plate 17, figs. 108 and 109.

Leiaster speciosus VON MARTENS (1866); SLADEN (1889); CLARK (1921).

Three specimens in collection taken from corals in Port Gajera Bay. Gorgeously brilliant red.

Pedicellariæ very inconspicuous, becoming noticeable only after drying. Pedicellariæ few, hardly one to each papula, usually found on margin of papular area and sometimes between two papulæ. Double-bladed valvate pedicellariæ enlarged at middle. Entire body covered by thick tough skin concealing outline of oval granular plates, arranged in regular longitudinal and transverse series. Longitudinal series of abactinal and marginal plates 7, regular longitudinal series of slightly sunken papular areas 8. Adambulacral spines slender and of uniform width, marked by a shallow groove between base and tips. Furrow spines united by continuous membrane. Actinal spines heavy, subcylindrical, a little longer than furrow spines. Largest specimen: R, 250 millimeters; r, 25; smaller: R, 150 millimeters;

r, 15; R = 10r. University of the Philippines E-716, E-746, E-762.

Genus LINCKIA Nardo (1834)

Key to the species of Linckia.

- a¹. Granulation of actinal surface extended to sides of ambulacral grooves so that furrow spines are separated from each other by vertical series of minute granules.
- b¹. Rays relatively short and stout; one madreporite; usually blue.
 - c¹. Median radial area free from papulae. R = 8.5r (average).
L. lævigata.
 - c². Median radial area not free from papulae. R = 5.3r.
L. lævigata var. *hondurensis*.
- b². Rays long and slender, 5 or 6, R = 6r; madreporites 2; no blue coloration *L. multifora*.
- a². Granulation of actinal surface not extended into ambulacral grooves; furrow spines not separated by granules..... *L. guildingii*.

LINCKIA LÆVIGATA (Linnaeus). Plate 15, figs. 89 and 91.

Pentadactylosaster miliaris LINCK (1733).

Asterias lævigata LINNÆUS (1758).

Linckia lævigata NARDO (1834); LUTKEN (1871); FISHER (1919); CLARK (1921).

Ophidiaster lævigata MÜLLER and TROSCHEL (1840).

Ophidiaster clathrata GRUBE (1864).

Linckia typus NARDO (1834).

Linckia crassa GRAY (1840).

Linckia brownii GRAY (1840).

Linckia miliaris VON MARTENS (1866).

Common large linckiid among corals in Port Galera Bay. In life both aboral and oral sides range from sky blue to marine blue and are usually uniform throughout. In some specimens the aboral side light blue and the oral light orange. Different specimens, however, show some slight differences in shade or intensity of blue. Young specimens usually lighter blue; average length of rays 150 millimeters, with one madreporite. No papular areas on oral side. Usually 5 short, stout rays, occasionally 4; some specimens with one or two rays shorter than the others. University of the Philippines E-605, E-607, E-747, E-748, E-751, E-757, E-758, E-871, E-896, and E-927.

LINCKIA LÆVIGATA var. HONDURENSIS var. nov. Plate 14, fig. 83.

Of the same color as *L. lævigata*. Differs however in size, arrangement of papular areas, number of rows of plates below inferomarginal plates, and furrow spines. Abactinal plates and papular areas arranged in alternating rows, this arrangement

very regular laterally but somewhat irregular dorsally. Median radial area as in *L. multifora* not free from papulæ. Below inferomarginal plates 4 rows of plates proximally and 3 rows distally. Furrow spines separated by very few granules in a perpendicular series. R, 80 millimeters; r, 15. Collected from Hondura shoal. Type specimen (University of the Philippines E-1040) deposited in the Philippine National Museum.

LINCKIA MULTIFORA (Lamarck). Plate 2, figs. 11 and 12.

Asterias multifora LAMARCK (1816).

Linckia leachii GRAY (1840).

Linckia multiforas GRAY (1866).

Linckia multiforis VON MARTENS (1866).

Linckia costæ RUSSO (1894).

Linckia multifora LUTKEN (1871); DE LORIOL (1885); FISHER (1919); CLARK (1921); HOLLY (1932).

A rare form with only two specimens obtained from corals in Port Galera Bay. Abactinal plates and papular areas irregularly arranged in 6 and 7 rows, respectively, between superomarginals. No median radial area free from papulæ. Madreporite 1. The subambulacral series of enlarged granules separated from furrow spines by 1 series of small granules. One specimen with 6 rays, others with 5. Rays not uniform in length. Longest ray 42 millimeters; shortest 30; radius of disc 7. University of the Philippines E-721.

LINCKIA GULDINGII Gray. Plate 14, figs. 80 and 81.

Scytaster stella DUCHASSAING (1850).

Ophidiaster ehrenbergii MÜLLER and TROSCHEL (1842).

Ophidiaster ornithopus MÜLLER and TROSCHEL (1842).

Linckia pacifica GRAY (1840).

Linckia diplax MÜLLER and TROSCHEL (1842).

Linckia nicobarica LUTKEN (1871).

Linckia ornithopus VERRILL (1871).

Linckia ehrenbergii DE LORIOL (1885).

Linckia guldningii GRAY (1840); SLADEN (1889); FISHER (1919); CLARK (1921).

Not common, only four specimens, three adult and one young, collected from corals in Port Galera Bay. Arm radius of adult 220 millimeters. Color dull grayish brown. This is so far the biggest linckiid found at the station. No abactinal plates conspicuously enlarged and swollen. Intermarginal poriferous areas not in a continuous series. Abactinal plates relatively small and numerous; papular areas large in 8 to 12 or more series, median ones very irregular and difficult to determine; papulæ numerous and small; size large, R, 220 millimeters. Rays relatively long;

color in young living specimens dull reddish or purple, more or less variegated with darker, becoming purplish, reddish brown, uniformly yellow-brown in the adult. University of the Philippines zoölogical collection E-604, E-672, E-1053.

Genus OPHIDIASTER Agassiz (1835)

OPHIDIASTER GRANIFER Lutken. Plate 2, figs. 9 and 10; Plate 6, fig. 34.

Ophidiaster granifer LUTKEN (1871); CLARK (1921).

Several specimens of this small species were obtained from under rocks among coral reefs in Port Galera Bay. In life abactinal side irregularly banded or mottled with purplish red and brownish gray. Anal opening surrounded by a small purplish red spot; rest of disc brownish gray; proximal third or fourth of arm purplish red; rest brownish gray, mottled with purplish red. Oral side yellowish brown speckled with tiny spots of purplish red.

Abactinal plates and papular areas distinctly arranged in 5 and 6 rows, respectively; markedly granular. Adambulacral spines distinctly conical and separated by fine granules. Furrow spines 3, the middle larger and arranged slightly obliquely, appearing as a double series of furrow spines. R, 30 millimeters; r, 7. University of the Philippines E-602, E-879, E-978.

OPHIDIASTER SQUAMEUS Fisher. Plate 13, figs. 69 and 70.

Ophidiaster squameus FISHER (1906); CLARK (1921).

A rare form; only one specimen has been collected during low tide at Gabino point under a rock. In life, abactinal side reddish purple, mottled with dull violet and grayish brown. Madreporite conspicuous, deep orange. Actinal side orange and reddish purple mottled with brown. Orange confined to adambulacral and ambulacral spines.

Abactinal plates covered with granules of different sizes and arranged in distinct longitudinal series. Poriferous areas arranged in eight longitudinal series. Anal opening surrounded by 6 conspicuous anal granules. Adambulacral spine about 50, higher than wide, conical, more conspicuous than those in *O. granifer*. Ambulacral region with 1 series of spines. R, 37 millimeters; r, 6; R = about 7r. University of the Philippines E-948.

Genus NARDOA Gray (1840)

Key to the Port Galera species of Nardoa.

a¹. Abactinal plates very slightly convex to markedly convex, but none high enough to be hemispherical or tuberculate.

*b*¹. Abactinal plates larger than papular areas.

*c*¹. Abactinal plates on distal part of ray not markedly and abruptly different from those on basal part. Abactinal plates elliptical in contour. Adambulacral spinelets in 3 series. Granules surmounting depressed convex plates, nearly uniform in size, polygonal, close set, two or three times the size of granules in depressions between plates..... *N. variolatus*.

*c*². Abactinal plates on distal part of ray markedly and abruptly smaller and more crowded than on basal part.

*d*¹. No intermarginal or actinal papulae. Abactinal plates roundish, 7 to 9 on basal third of ray; adambulacral armature in 3 series; abactinal papular areas with granules conspicuously larger than others.

N. squamulosa.

*d*². With intermarginal series of papulae.

*e*¹. Abactinal plates 10 across ray at base, smaller and less convex; rays shorter and thicker, not especially attenuate at tip; adambulacral armature in 2 series *N. novæ-caledoniæ*.

*e*². Abactinal plates larger, 9 to 11 across ray; at base larger; adambulacral armature in 3 series.

N. mollis.

*b*². Abactinal plates smaller than papular area.

*c*¹. Abactinal plates 10 to 12 across base of ray. Lateral abactinal plates smaller and irregular; with an intermediate series of papulae; furrow spines 4; rays long, slender, and tapering to a sharp point..... *N. lemonnieri*.

*c*². Abactinal plates smallest of any known species, at least 12 to 13 across ray at base, those of distal third or fourth small and crowded, but the area not conspicuously differentiated from rest of abactinal surface; lateral abactinal plates abruptly much smaller than regular superomarginals, which are thus very conspicuous; a single series of actinal intermediate plates extending to the end of the ray; adambulacral armature 3 to 5 spines..... *N. pauciforis*.

*a*¹. Some abactinal plates hemispherical or nearly so, others less markedly convex or else variably convex or hemispherical, subcylindrical, or subconical; tubercles as high as their breadth at base.

*b*¹. Abactinal plates very numerous and nearly all equal, some conspicuously more convex than others, the most prominent hemispherical, but not so high as wide. Tubercles scattered, small, 2 millimeters or less in diameter..... *N. tuberculata*.

*b*². Abactinal plates very unequal in size, larger ones forming thick subconical or dome-shaped tubercles covered with granules. Abactinal tubercles 30 or 40, large, 3 to 5 millimeters in diameter *N. frianti*.

NARDOA VARIOLATUS (Lamarck). Plate 11, figs. 57 and 58.

Asterias variolatus LAMARCK (1816).

Linckia variolata NARDO (1834).

Nardoa variolata GRAY (1840); SLADEN (1889); CLARK (1921).

Nardoa agassizii GRAY (1840).

Nardoa variolatus FISHER (1919).

Occasionally found among corals in Port Galera Bay. Abactinal plates much larger than papular areas, elliptical in contour. Adambulacral spinelets in 3 series. Granules covering abactinal plates nearly uniform in size, two or three times the size of the granules in the depressions between the plates. University of the Philippines E-593.

NARDOA SQUAMULOSA Koehler. Plate 12, figs. 67 and 68.

Nardoa squamulosa KOEHLER (1910); FISHER (1919).

A rare species found among living corals of Port Galera Bay. Abactinal plates large, in 7 to 8 irregular rows at base of ray, becoming more irregular at distal part, covered with larger central granules and smaller peripheral ones. Adambulacral armature in 3 series with 3 or 4 furrow spines. $R = 5\frac{1}{2}r$. University of the Philippines E-618, E-875.

NARDOA NOVÆ-CALEDONIÆ (Perrier). Plate 11, figs. 59 and 60.

Scytaster novæ-caledoniae PERRIER (1875).

Scytaster gamophia PERRIER (1875).

Nardoa novæ-caledoniae SLADEN (1889); FISHER (1919); CLARK (1921).

Found among corals of Port Galera Bay. Closely resembles *N. variolatus*, from which it differs in the size of distal abactinal plates and the central granules on plates which are very conspicuous. Abactinal plates smaller and less convex. Inter-marginal series of papulae present. Length of ray variable. Adambulacral armature in 2 series with 4 furrow spines. $R = 5r$. University of the Philippines E-615, E-874.

NARDOA MOLLIS de Loriol. Plate 11, figs. 61 and 62.

Nardoa mollis DE LORIOL (1891); FISHER (1919).

Nardoa bellonæ KOEHLER (1910).

Found among coral reefs of Port Galera Bay. Abactinal plates larger, 9 to 11 across ray at base, those of distal third crowded. Numerous conspicuous pedicellariæ in papular areas. Distal third of ray narrower than the rest. Adambulacral armature in 3 series with 3 or 4 furrow spines. $R = 7\frac{1}{2}r$. University of the Philippines E-595, E-873.

NARDOA LEMONNIERI Koehler. Plate 10, figs. 55 and 56.

Nardoa lemonnieri KOEHLER (1910); FISHER (1919).

Apparently rare, only one specimen in the collection, taken by members of 1912 expedition from Port Galera Bay. Easily recognized because of its long, slender, tapering ray with rather sharp extremity. Agrees with the description of Fisher 1919. University of the Philippines E-872.

NARDOA PAUCIFORIS (von Martens). Plate 10, figs. 53 and 54; Plate 12, figs. 63 and 64.

Linckia pauciforis VON MARTENS (1866).

Nardoa finschi DE LORIOL (1891).

Nardoa pauciforis SLADEN (1889); FISHER (1919); CLARK (1921).

Occasionally found among corals of Port Galera Bay. Abactinal side with 6 or 7 alternate reddish brown and orange brown bands, extending to ambulacral groove. Abactinal plates small, 12 across ray at base, those of distal third small and crowded, lateral abactinal plates abruptly much smaller than the regular superomarginals which are very conspicuous; adambulacral armature in 3 series with 3 to 5 furrow spines. R, 130 millimeters; r, 20; usually R = 7r. University of the Philippines E-594, E-596, E-750, E-899.

NARDOA TUBERCULATA (Müller and Troschel). Plate 14, fig. 74.

Ophidiaster tuberculatus MÜLLER and TROSCHEL (1840).

Nardoa tuberculata GRAY (1840, 1866); SLADEN (1889); KOEHLER (1910); FISHER (1919); CLARK (1921).

Scytaster tuberculatus PERRIER (1875).

Most common species of genus found among corals of Port Galera Bay. Told from *N. frianti* by its low and broad tubercles. In life brown-yellow with dark blood-red transverse bands. Adambulacral armature in 3 series, with 4 and 5 furrow spines. R, 130 millimeters; r, 20; R = 6½r. University of the Philippines E-597, E-609, E-613, E-743, E-864.

NARDOA FRIANTI Koehler. Plate 12, figs. 65 and 66.

Nardoa frianti KOEHLER (1910); FISHER (1919); CLARK (1921).

A very well-marked species found among corals of Port Galera Bay; not very common. In life pinkish red, rays with 3 to 4 red indistinct bands. Papular areas light violet, those of distal third and above superomarginals deeper violet. Red band on oral side more distinct but irregular. Abactinal plates unequal in size, larger ones forming thick subconical or dome-shaped tubercles covered with granules. Abactinal tubercles numerous, 30 or more, covered with conical granules which are large and conspicuous at center. Adambulacral armature in 3 series, with furrow spines ranging from 2 to 4. R = 8r. University of the Philippines E-599, E-742, E-891.

Order SPINULOSA Perrier

Pedicellariæ few or absent, never forcipiform; abactinal skeleton reticulate or imbricated, sometimes absent; abactinal spines always present, usually numerous, isolated in groups, or forming regular fascicules and pseudopaxillæ; marginal plates usually inconspicuous; papulæ dorsal only or also intramarginal and actinal; ambulacral plates not crowded and compressed, actinostome with prominent adambulacral plates; tube feet with well-developed sucking disc, usually biserial; mouth plates medium-sized or large.

ASTERINIDÆ

Marginal plates small, in some forms inconspicuous and with their axes convergent. Abactinal skeleton composed of imbricating and usually lamelliform plates, notched on one side and bearing spines at free margin; or irregular rounded plates with tufts of spinelets. Actinal interradial areas with imbricating plates bearing spines. No pedicellariæ.

Genus ASTERINA Nardo (1834)

ASTERINA (PATIRIELLA) EXIGUA (Lamarck). Plate 6, fig. 33.

Asterias exigua LAMARCK (1816).

Asterina calcarata KOEHLER (1909).

Asterina exigua PERRIER (1875), KOEHLER (1910); CLARK (1923).

Patiriella exigua VERRILL (1913); FISHER (1919); CLARK (1928).

Most common small starfish found in rocky and stony shore line. Specimens collected from rocks near "shipwreck point" of Varadero Bay and from Recodo of Paniquian Island, Port Galera. Others from Saint Paul Bay, Palawan. Rays 4 to 7. Color resembles that of the bottom where they are found, speckled with reddish green of various shades.

Abactinal plates covered with stout, short, and stunted spines, appearing like granules. Actinal plates with single large pointed spine. Furrow spines 3, marginal mouth spines 4. R, 12 millimeters; r, 10. University of the Philippines E-598, E-740.

ASTERINA CORONATA EUERCES Fisher. Plate 4, fig. 20.

Asterina cristata euerces FISHER (1917).

Asterina coronata euerces FISHER (1918, 1919).

Small starfishes found under rocks near Gabino Point, Varadero Bay. Color in life, a combination of brownish gray and deep green on aboral side; brownish gray confined to interbrachial region and tip of rays; latter color confined to central disc and rays, except anal opening. Oral side yellowish brown

speckled with dirty green patches. Abactinal secondary plates and papulae few. Abactinal spinelets smaller and more pointed or less united at base, forming a tuft of spinelets, some of which are crescent-shaped. Those of disc, around anal region, smaller. Tufts of 4 or 5 spinelets on actinal side more or less uniform. One series of adambulacral spines with 7 or 8 furrow spines and 8 or 9 marginal mouth spines. R, 18 millimeters; r, 9. University of the Philippines E-632, E-949.

ASTERINA CORONATA PUERTO-GALERÆ subsp. nov. Plate 4, figs. 23 and 24.

Collected from North Channel of Port Galera Bay. Resembles *Asterina coronata euerces* in number of spinelets (10 to 15) on inconspicuous abactinal plates of radial part of ray and of actinal plates adjacent to adambulacral plates (4 or 5). Resembles *Asterina coronata cristata* in the absence of abactinal pedicellariæ and in the number of furrow spines, usually 6. Differs from both in number of marginal mouth spines (15) and in their being united by a membrane leaving the distal fifth free. It resembles both in general appearance as well as in size. Biggest specimen: R, 18 millimeters; r, 8. Type specimen of new subspecies (University of the Philippines E-626) deposited in the Philippine National Museum.

Family ECHINASTERIDÆ Verrill

Abactinal skeleton reticulate, often irregular, formed of small imbricating plates, bearing isolated or grouped spines. Disc sometimes large but usually small, with rays elongate and often subcylindrical. Septum single, interbrachial. Actinostomial margin defined by adambulacral plates. Ambulacral tube feet biserial. Pedicellariæ rarely present.

Subfamily ACANTHASTERINÆ Sladen

Disc large, rays numerous. Armed with large isolated spines covered with membrane beset with calcareous granules. Madreporiform bodies numerous. Forciform pedicellariæ present.

Genus ACANTHASTER Gervais (1841)

ACANTHASTER PLACCI (Linnæus). Plate 8, fig. 41; Plate 16, fig. 99; Plate 17, figs. 104 and 105.

Asterias planci LINNÆUS, 1758.

Asterias echinites ELLIS and SOLANDER (1786).

Stellonja echinites AGASSIZ (1835).

Echinaster ellisi (part) GRAY (1840).

Acanthaster echinus GERVAIS (1841).

Echinaster solaris MÜLLER and TROSCHEL (1842).

Acanthaster echinites LUTKEN (1871); PERRIER (1875); DÖDERLEIN (1888).

Acanthaster planci VERRILL (1914); FISHER (1919); CLARK (1921).

Common among corals and rocks in Port Galera Bay and Sabang Cove. The largest specimen so far collected measures 100 millimeters in diameter from tip to tip of ray. Aboral side with a general background of grayish blue, distal three-fourths of ray uniformly blue, the lateral together with proximal fourth mottled with purple and red granules; disc bluish, mottled with light yellowish and purplish granules; base of column of spines uniformly bluish black. Abactinal spines long, acicular, borne on high columns or pedicels; spines of disc, including pedicels, 10 to 25 millimeters long, those at distal two-thirds of ray usually much stouter and longer, 25 to 40 millimeters. Actinal spines with fine granulation, or in large part nearly smooth; 3 conspicuous furrow spines with very short, stubby spinelets at both ends; madreporites 4 to 8. Rays 12 to 17; average length of ray 120 millimeters; $R = 2r$. University of the Philippines E-685, E-744, E-745, E-760, E-843, E-894, E-1031.

ACANTHASTER MAURITIENSIS de Loriol. Plate 8, fig. 42.

Acanthaster mauritiensis DE LORIOL (1885).

Only one specimen obtained from "ship-wreck point" of Varadero Bay. Color duller than in *A. planci*; tip of spines slightly pinkish orange. Abactinal spines distinctly short, 3 to 4 millimeters, those of disc not reaching one-sixth the length of ray. Spines of ray 5 to 7 millimeters, slightly longer than those of disc. Furrow spines 3, middle spine much larger than the lateral ones. Rays 15; R , 43 millimeters; r , 25. University of the Philippines E-1032.

Subfamily ECHINASTERINÆ Viguer

Disc small or medium-sized, rays 5 or 6. Spinulation small and simple; spinelets isolated or in groups. Pedicellariæ absent.

Genus ECHINASTER Müller and Troschel (1840)

ECHINASTER CALLOSUS von Marenzeller. Plate 13, figs. 71 and 72; Plate 17, figs. 106 and 107.

Echinaster callosus VON MARENZELLER (1885); KOEHLER (1910); FISHER (1919).

Found among corals in Port Galera Bay, near Northwest Channel. Disc quite small, rays a trifle swollen above base.

Papular areas sharply limited by superomarginal plates, no intermarginal or actinal papulae. Rods irregularly branched, scattered on outer layer of integument. Stout conical spine on every fourth or fifth superomarginal and inferomarginal. Similar large tubercular spines found irregularly scattered all over abactinal surface. Average length of arm 80 millimeters; arms of largest specimen 150 millimeters long. University of the Philippines E-610, E-741.

ECHINASTER LUZONICUS (Gray). Plate 5 fig. 29; Plate 13, fig. 73.

Othilia luzonica GRAY (1840).

Othilia eridanella MÜLLER and TROSCHEL (1842); PERRIER (1875); DE LORIOL (1893); DÖDERLEIN (1896); KOEHLER (1910).

Echinaster eridanella MÜLLER and TROSCHEL (1842); CLARK (1921).

Echinaster luzonicus MÜLLER and TROSCHEL (1842); CLARK (1921).

Apparently common among corals in Port Galera Bay. Abactinal side dark olive brown. A few specimens almost black, roughened with fine spines irregularly intermixed with single pore papulae. Preserved specimens rusty or red-brown, or lighter with slight shade of orange-brown. Retracted papulae resembling sunken pits. Surface of disc and ray corrugated. Oral surface slightly lighter in color. Rays 4 to 7, 6 in most specimens, cylindrical, often very slender, not uniform in length; adambulacral plates usually with a distinct subambulacral spinelet, so that no conspicuous bare area on each side of the furrow is visible; actinal spinelets numerous and small. Occasionally a single arm regenerates into a whole animal. One specimen has a small bud with four rays attached to the abactinal disc, apparently caused by injury followed by regeneration. Average length of ray 70 millimeters, longest 100; radius of disc 15. University of the Philippines E-608, E-619, E-669, E-731, E-755, E-756, E-897.

ECHINASTER PURPUREUS Savigny. Plate 16, figs. 100 to 103.

Echinaster purpureus SAVIGNY (1809); GRAY (1866); CLARK (1921).

Othilia purpurea GRAY (1840); FISHER (1919).

Echinaster fallax MÜLLER and TROSCHEL (1842); PERRIER (1875); DE LORIOL (1885); KOEHLER (1910).

A rare species found with *E. luzonicus* in the same coral-reef region. Differs from *E. luzonicus* in having stout and terete rays. Subambulacral spinelets absent, a wide bare space with or without spinelets near marginal spinelet. One specimen with 5 rays of unequal length and one with 7. Resembles *E. luzonicus* in color and in general appearance. University of the Philippines E-730, E-885.

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ILLUSTRATIONS

PLATE 1

- FIG. 1. *Astropecten polyacanthus*, aboral side (E-801).
2. *Astropecten polyacanthus*, oral side (E-801).
3. *Astropecten polyacanthus*, aboral side (partly destroyed) (E-754).
4. *Astropecten polyacanthus*, oral side (E-754).
5. *Astropecten phragmorus*, aboral side (E-1005).
6. *Astropecten phragmorus*, oral side (E-1005).

PLATE 2

- FIG. 7. *Astropecten polyacanthus*, aboral side (E-684).
8. *Astropecten polyacanthus*, oral side (E-684).
9. *Ophidiaster granifer*, aboral side (E-602).
10. *Ophidiaster granifer*, oral side (E-602).
11. *Linckia multifora*, aboral side (E-721).
12. *Linckia multifora*, oral side (E-721).

PLATE 3

- FIG. 13. *Astropecten phragmorus*, aboral side (E-1028).
14. *Archaster typicus*, aboral side (E-617).
15. *Archaster typicus*, aboral side (E-749).
16. *Archaster typicus*, oral side (E-749).
17. *Archaster typicus*, aboral side (E-785).
18. *Archaster typicus*, oral side (E-785).

PLATE 4

- FIG. 19. *Luidia maculata*, aboral side (E-737).
20. *Asterina coronata euerces*, aboral and oral sides (E-953).
21. *Hippasteria philippinensis* sp. nov., aboral side (E-953).
22. *Hippasteria philippinensis* sp. nov., oral side (E-953).
23. *Asterina coronata puerto-galeræ* subsp. nov., aboral side (E-626).
24. *Asterina coronata puerto-galeræ* subsp. nov., oral side (E-626).

PLATE 5

- FIG. 25. *Pentaceropsis tyloderma*, aboral side (E-836).
26. *Pantaceropsis tyloderma*, oral side (E-836).
27. *Pentaceropsis tyloderma* var. *mindorensis* var. nov., aboral side (E-1034).
28. *Oreaster nodosus*, aboral side (E-886).
29. *Echinaster luzonicus*, aboral side with a bud (E-1052).
30. *Stellaster incei*, oral and aboral sides (E-783).

PLATE 6

- FIG. 31. *Oreaster alveolatus*, aboral side (E-761).
 32. *Oreaster alveolatus*, oral side (E-761).
 33. *Asterina (Patiriella) exigua*, oral and aboral sides (E-740).
 34. *Ophidiaster granifer*, aboral and oral sides (E-879).

PLATE 7

- FIG. 35. *Culcita novæ-guineæ* var. *plana*, aboral side (E-848).
 36. *Culcita novæ-guineæ* var. *plana*, oral side (E-848).
 37. *Culcita novæ-guineæ* var. *acutispinosa*, aboral side (E-849).
 38. *Culcita novæ-guineæ* var. *acutispinosa*, oral side (E-849).

PLATE 8

- FIG. 39. *Culcita novæ-guineæ* var. *plana*, aboral side (E-926).
 40. *Culcita novæ-guineæ* var. *acutispinosa*, aboral side (E-914).
 41. *Acanthaster planci*, aboral side (E-843).
 42. *Acanthaster mauritiensis*, aboral side (E-1032).
 43. *Gymnasteria carinifera*, aboral side (E-714).
 44. *Gymnasteria carinifera*, oral side (E-714).

PLATE 9

- FIG. 45. *Fromia japonica*, aboral side (E-772).
 46. *Fromia japonica*, oral side (E-772).
 47. *Fromia elegans*, aboral side (E-600).
 48. *Fromia elegans*, oral side (E-600).
 49. *Fromia eusticha*, aboral side (E-771).
 50. *Fromia eusticha*, oral side (E-771).

PLATE 10

- FIG. 51. *Fromia elegans*, aboral side (E-892).
 52. *Fromia elegans*, oral side (E-892).
 53. *Nardoa pauciforis*, aboral side (E-750).
 54. *Nardoa pauciforis*, oral side (E-750).
 55. *Nardoa lemonnieri* aboral side (E-872).
 56. *Nardoa lemonnieri*, oral side (E-872).

PLATE 11

- FIG. 57. *Nardoa variolatus*, aboral side (E-593).
 58. *Nardoa variolatus*, oral side (E-593).
 59. *Nardoa novæ-caledoniæ*, aboral side (E-874).
 60. *Nardoa novæ-caledoniæ*, oral side (E-874).
 61. *Nardoa mollis*, aboral side (E-873).
 62. *Nardoa mollis*, oral side (E-873).

PLATE 12

- FIG. 63. *Nardoa pauciforis*, aboral side (E-596).
 64. *Nardoa pauciforis*, oral side (E-596).
 65. *Nardoa frianti*, aboral side (E-891).
 66. *Nardoa frianti*, oral side (E-891).
 67. *Nardoa squamulosa*, aboral side (E-891).
 68. *Nardoa squamulosa*, oral side (E-875).

PLATE 13

- FIG. 69. *Ophidiaster squameus*, aboral side (E-948).
 70. *Ophidiaster squameus*, oral side (E-948).
 71. *Echinaster callosus*, aboral side (E-610).
 72. *Echinaster callosus*, oral side (E-610).
 73. *Echinaster luzonicus*, aboral and oral sides (E-608).

PLATE 14

- FIG. 74. *Nardoa tuberculata*, oral and aboral sides (E-743).
 75. *Culcita novæ-guineæ* var. *acutispinosa*, aboral side (E-1050).
 76. *Halityle regularis*, aboral side (E-842).
 77. *Halityle regularis*, oral side (E-842).
 78. *Pentaceropsis tyloderma*, aboral side (E-1033).
 79. *Pentaceropsis tyloderma*, aboral side (E-950).
 80. *Linckia guildingii*, aboral side (E-672).
 81. *Linckia guildingii*, oral side (E-672).
 82. *Oreaster nodosus* var. *honduræ* var. nov., aboral side (E-1044).
 83. *Linckia lavigata* var. *honduræ* var. nov., oral and aboral sides (E-1040).

PLATE 15

- FIG. 84. *Culcita novæ-guineæ* var. *typica*, aboral side (E-739).
 85. *Culcita novæ-guineæ* var. *typica*, oral side (E-739).
 86. *Choriaster granulatus*, aboral side (E-856).
 87. *Choriaster granulatus*, oral side (E-856).
 88. *Oreaster doederleini*, aboral side (E-857).
 89. *Linckia lavigata*, aboral and oral sides (E-605).
 90. *Oreaster nodosus*, aboral side (E-752).
 91. *Linckia lavigata*, aboral side (E-927).

PLATE 16

- FIG. 92. *Culcita novæ-guineæ*, aboral side (E-847).
 93. *Culcita novæ-guineæ*, oral side (E-847).
 94. *Gymnasteria carinifera*, aboral side (E-736).
 95. *Gymnasteria carinifera*, oral side (E-736).
 96. *Culcita novæ-guineæ* var. *typica*, aboral side (E-851).
 97. *Culcita novæ-guineæ* var. *typica*, oral side (E-851).
 98. *Culcita novæ-guineæ* var. *plana*, aboral side (E-895).
 99. *Acanthaster planci*, aboral side (E-744).
 100. *Echinaster purpureus*, aboral side (E-730).
 101. *Echinaster purpureus*, oral side (E-730).
 102. *Echinaster purpureus*, aboral side (E-885).
 103. *Echinaster purpureus*, oral side (E-885).

PLATE 17

- FIG. 104. *Acanthaster planci*, aboral side (E-745).
 105. *Acanthaster planci*, oral side (E-745).
 106. *Echinaster callosus*, aboral side (E-741).
 107. *Echinaster callosus*, oral side (E-741).
 108. *Leiaster speciosus*, oral side (E-746).
 109. *Leiaster speciosus*, oral side (E-746).

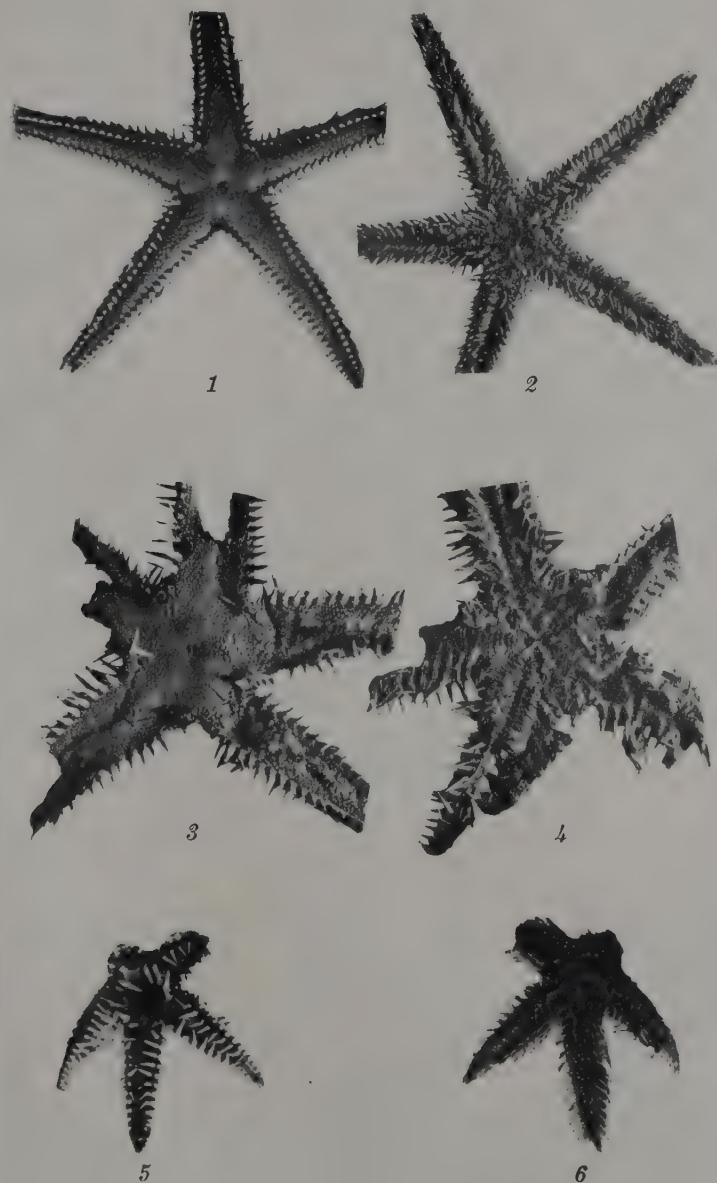
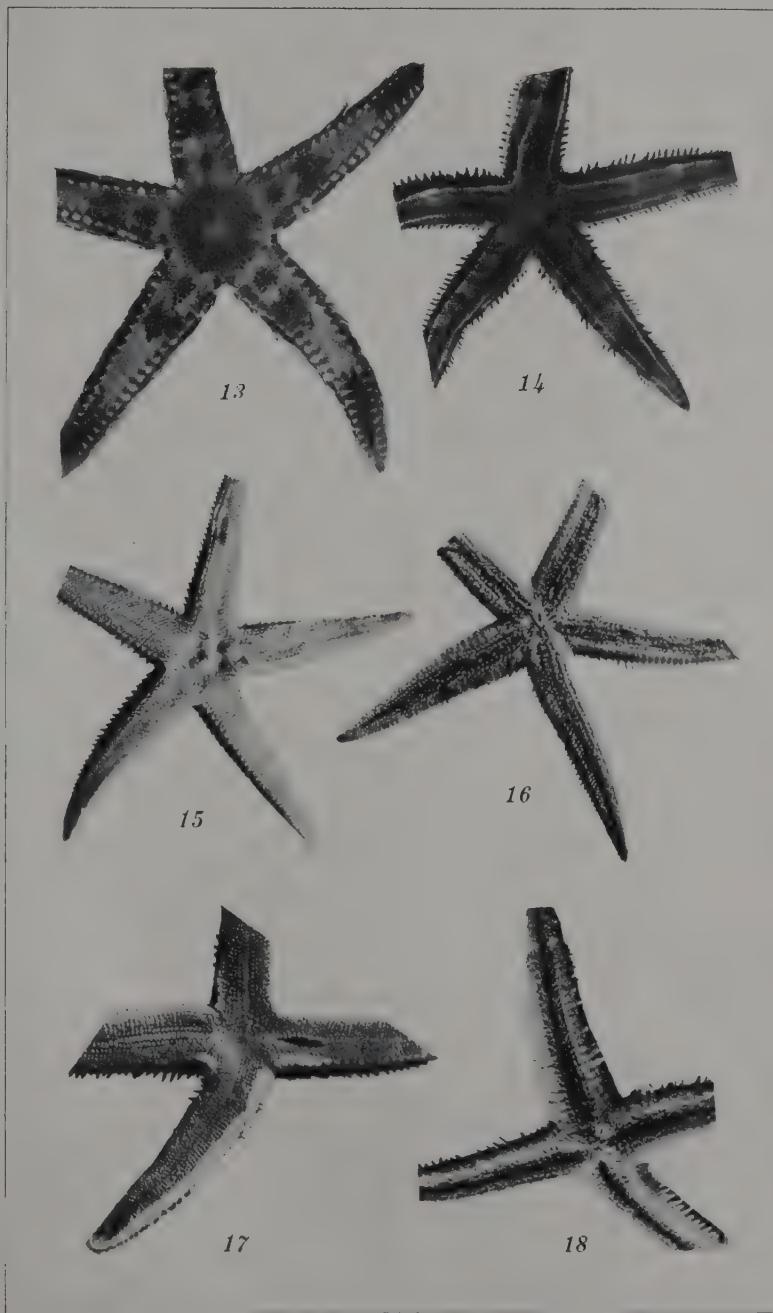
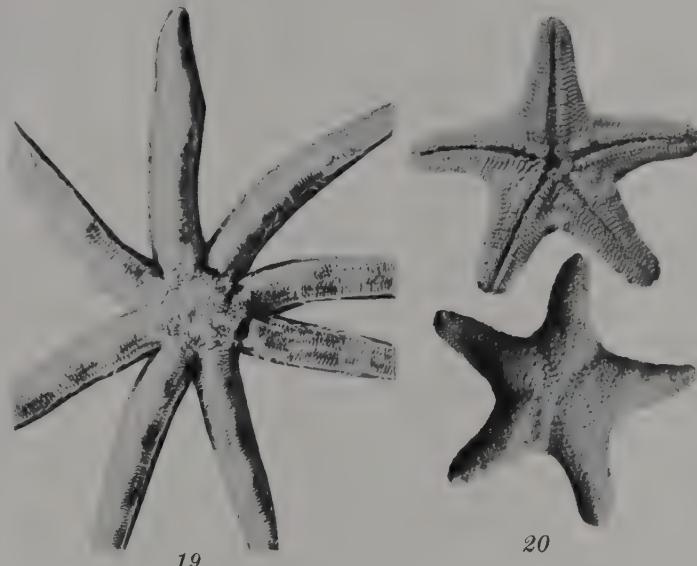


PLATE 1.







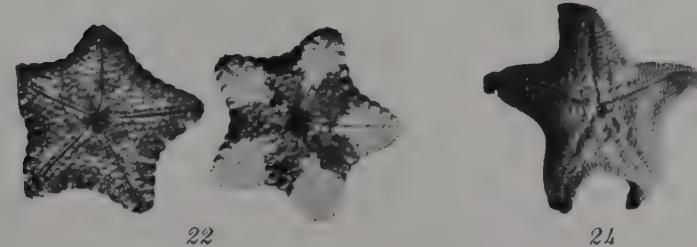
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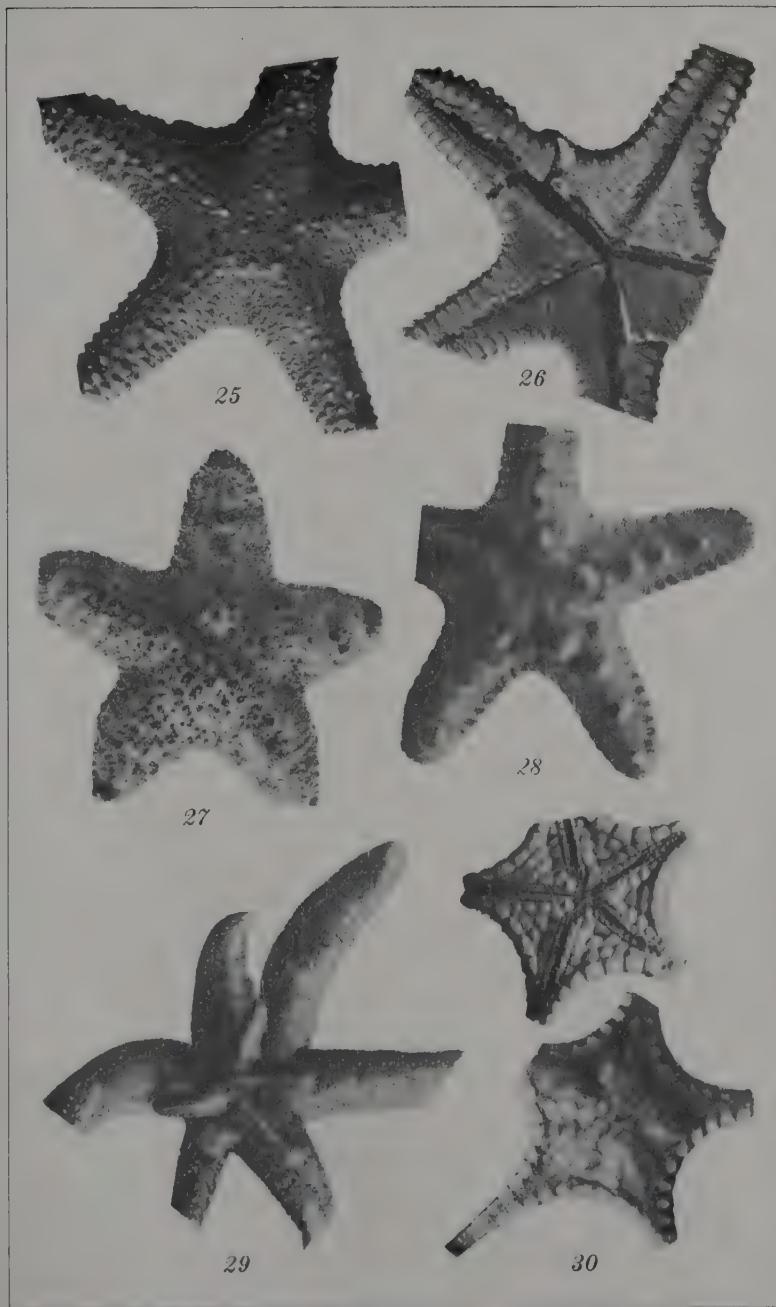
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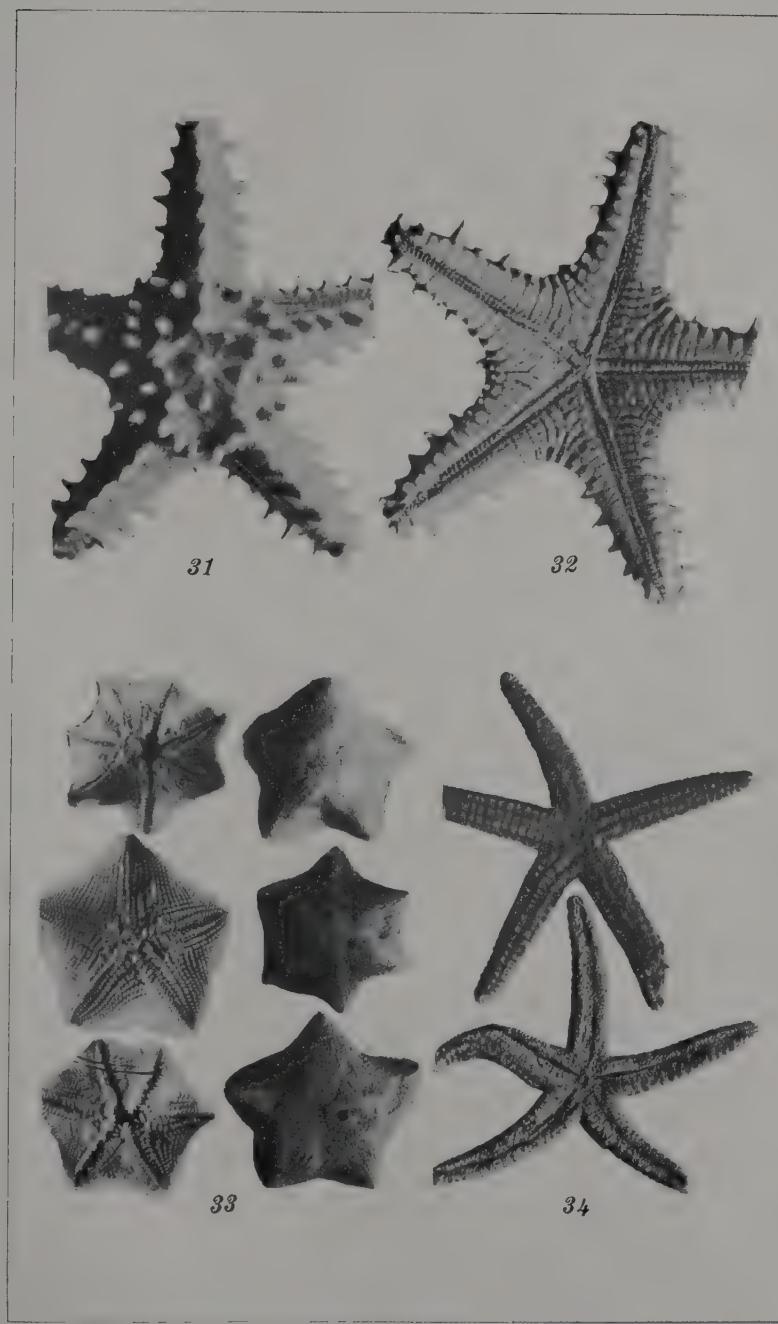
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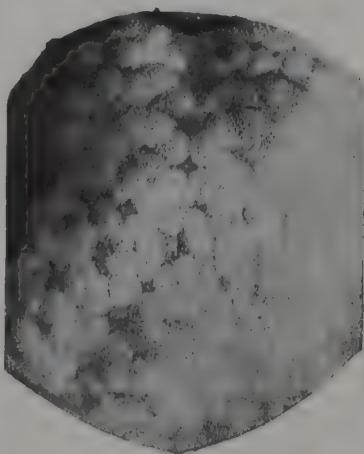




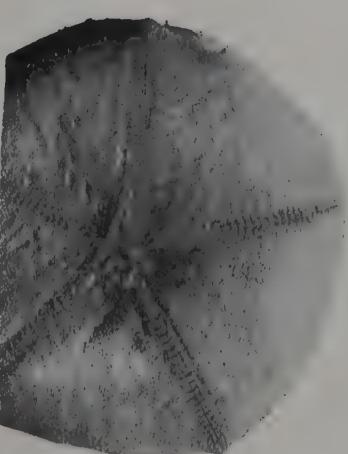
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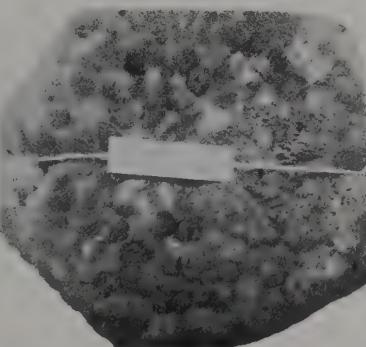
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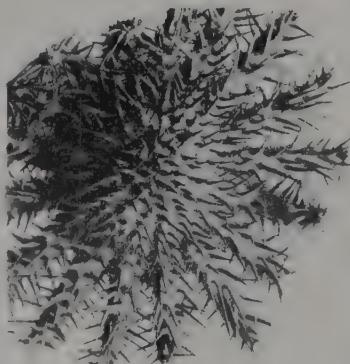
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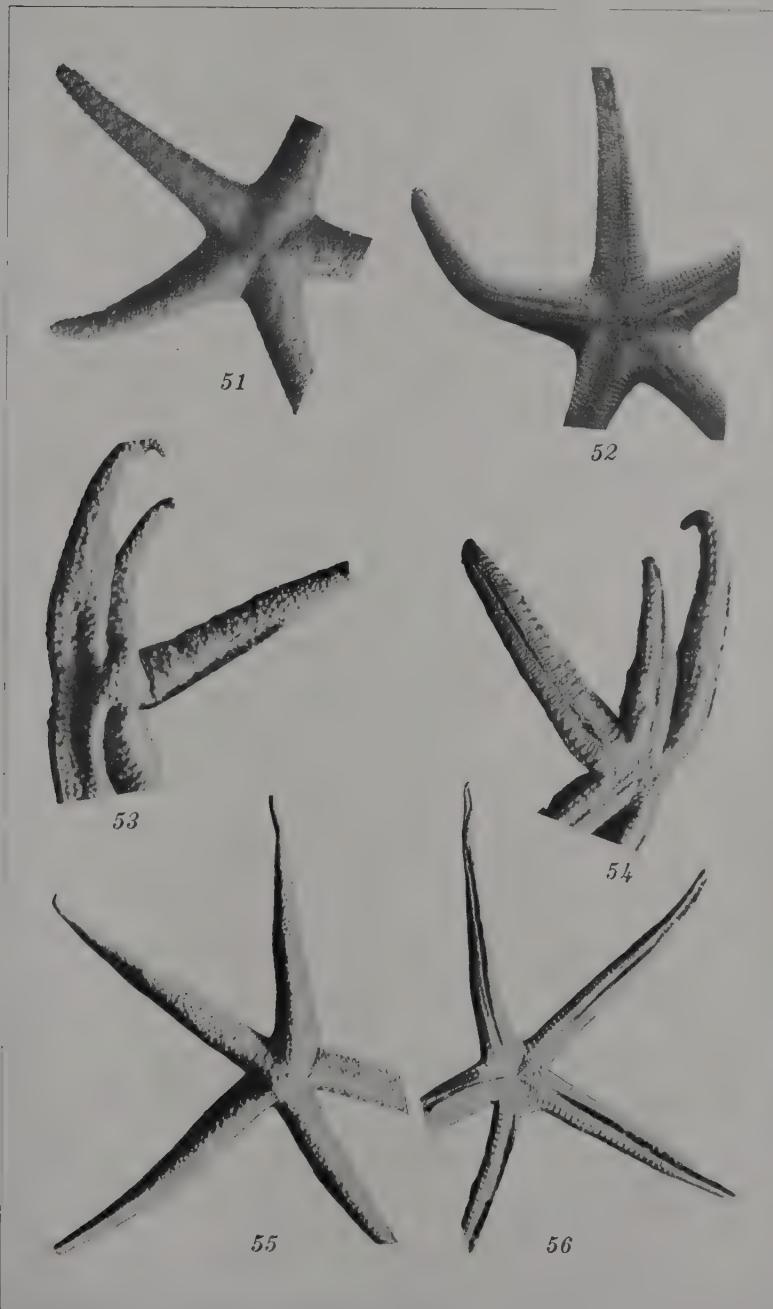


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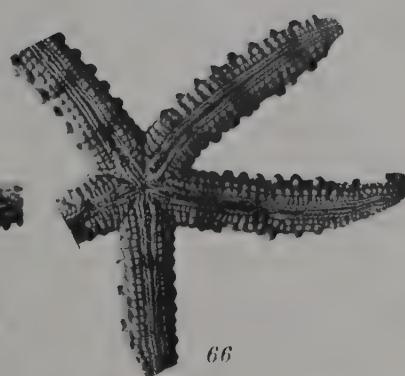
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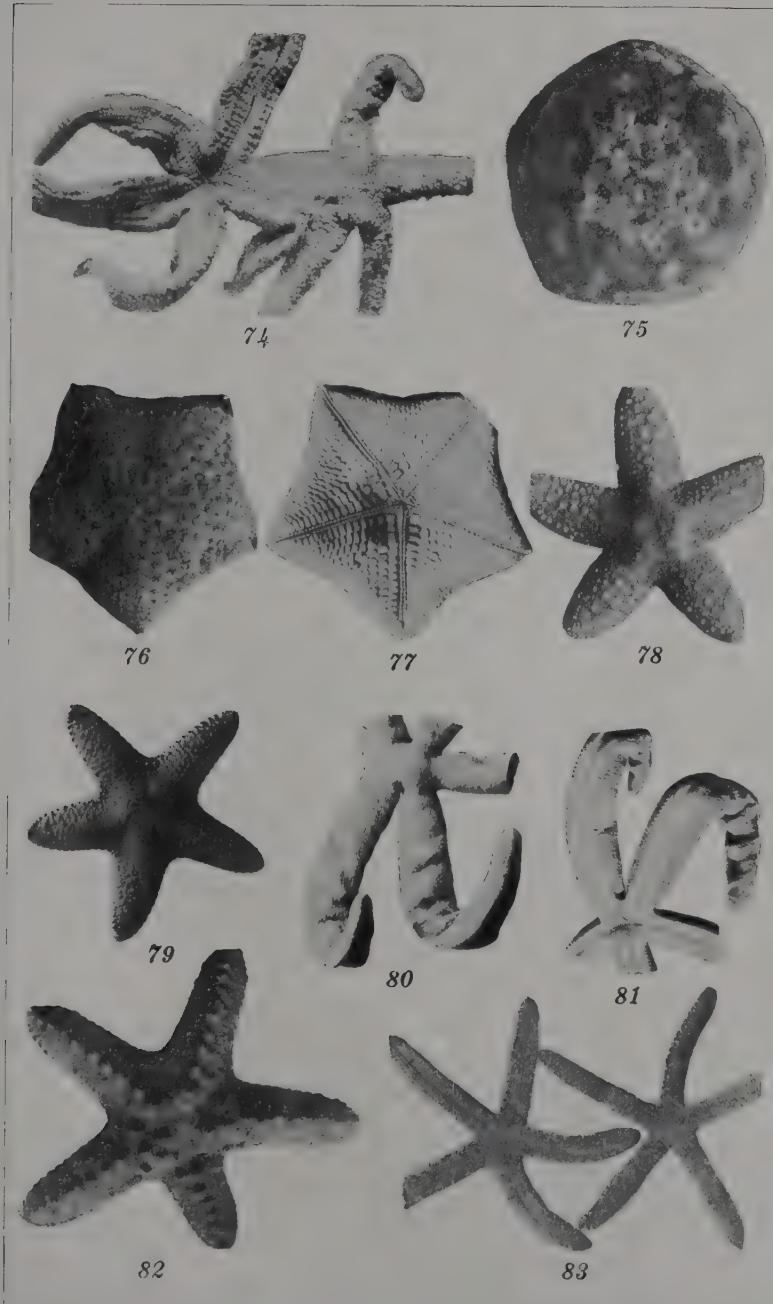
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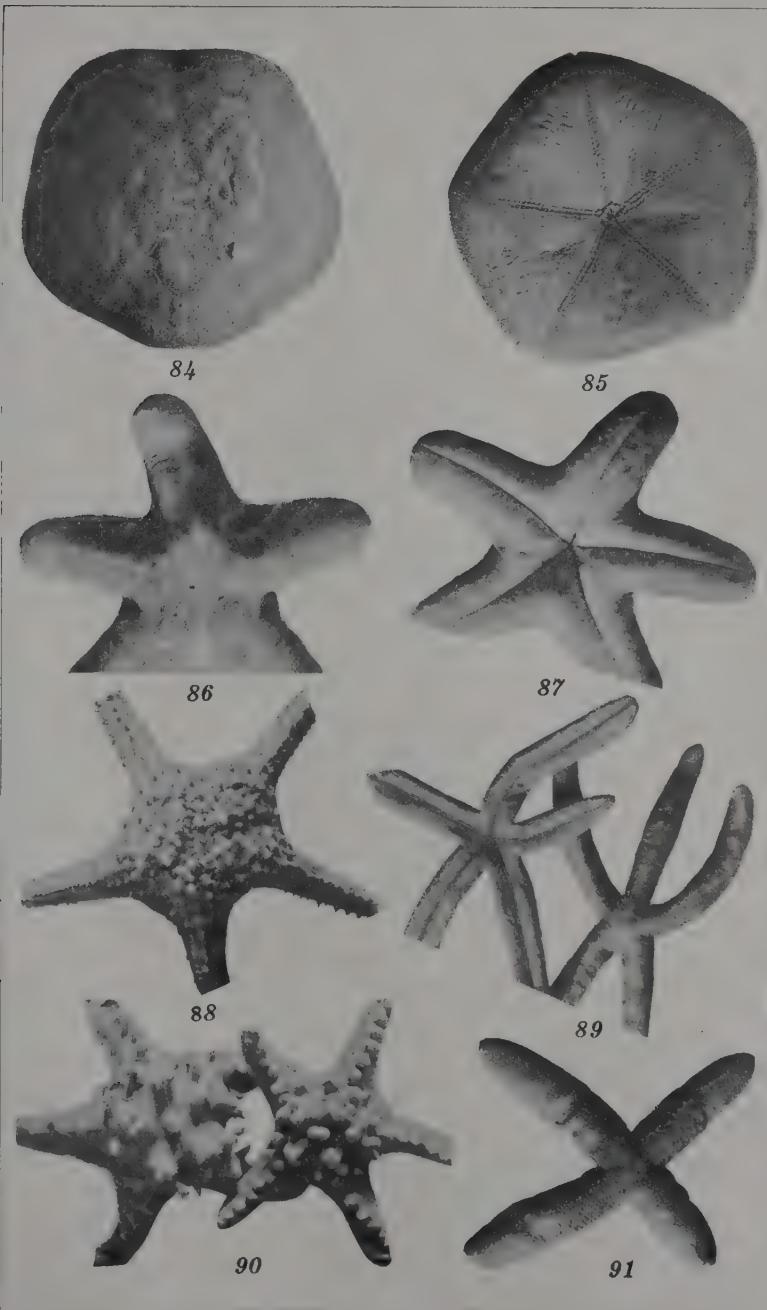


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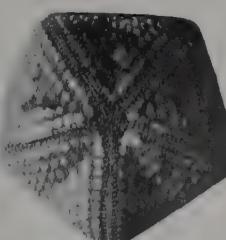








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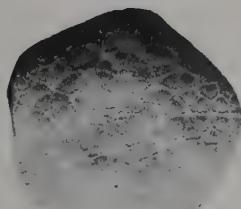
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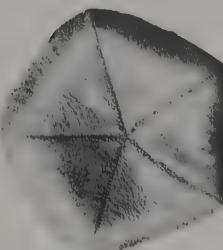
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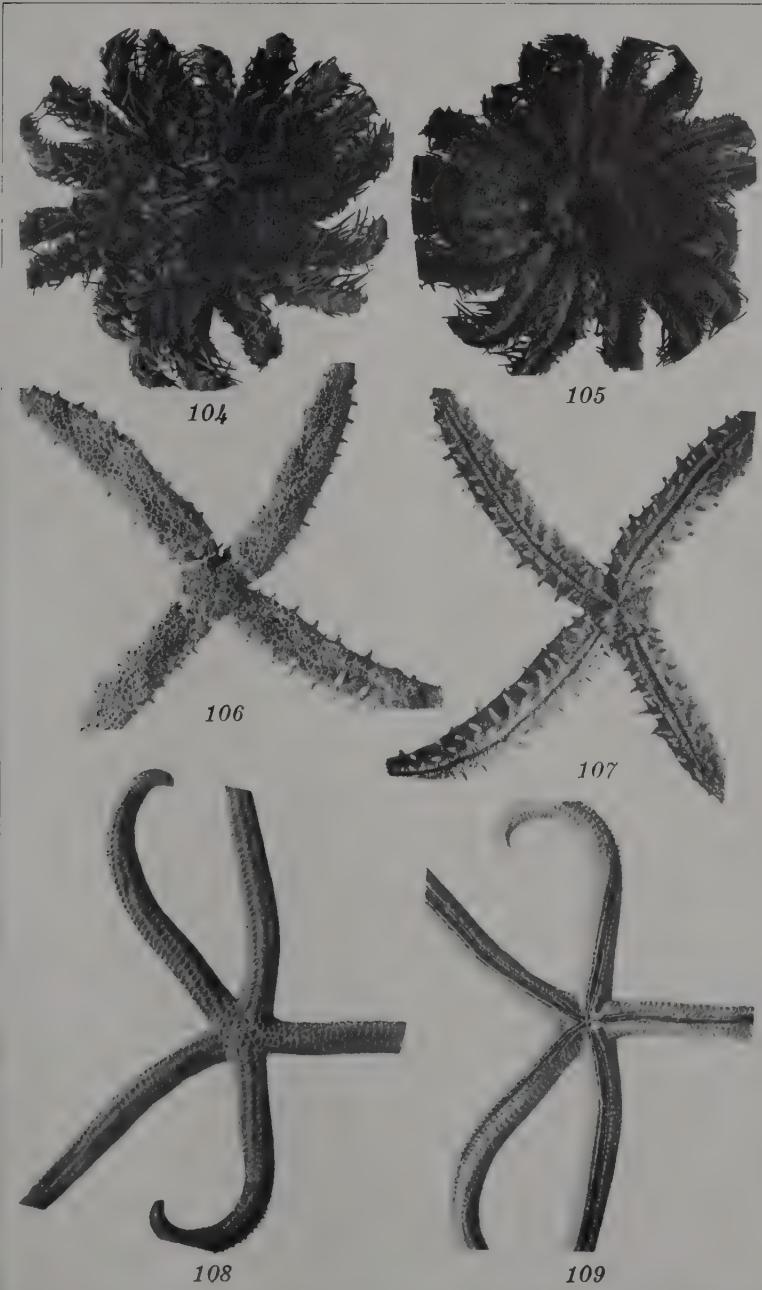
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ECOLOGICAL STUDIES ON MARINE RELICS AND LAND-LOCKED ANIMALS IN INLAND WATERS OF NIPPON

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TWO TEXT FIGURES

During my investigations on the fresh-water fisheries and benthonic fauna of Japanese lakes I had opportunity to observe many marine relict and land-locked animals. As these animals have so far received very little attention on the part of zoölogists, I will here give a review of them from the ecological and zoögeographical points of view.

MARINE RELICS

By marine relict we understand those animals which have been cut off from the ocean and which persisted in bodies of water that gradually became fresh, so that they finally became fresh-water forms. Original stocks of them usually exist in the ocean, but no active immigration is possible under the present conditions. There are also many animals which have recently taken up life in fresh water by slowly migrating up rivers, and occasional visitors from the sea, but these are left out of consideration in this paper. We must here remember that no large groups of animals, except perhaps bony fishes, are believed to originate outside of the ocean, and the fresh-water fauna was formed by the oboceanic migration of marine animals.

In Nippon there are many marine relict, of which the animals enumerated below are representative. Nippon has never been subjected to glaciation, except in the high mountain regions, and accordingly our marine relict have a different origin from those found in some European and North American lakes, where they are closely associated with the glacial period. Our marine relict are distributed only in the lakes of marine origin (text fig. 1).

Neomysis intermedia (Czerniavsky) [*Schizopoda*].—This animal is found in numerous relic lakes of marine origin in Kamchatka, northern and southern Kuriles, Saghalin, Hokkaido, and

Honshu. In some lakes on the Japan seacoast of southern Honshu there occurs a closely related species, *Neomysis awatschensis* (Brand).

Exosphaeroma oregonensis Dana [Isopoda].—The range of distribution of this animal includes Kamchatka, Alaska, Nippon, and southern China. In Nippon it is very common in the lakes of Kunasiri-sima (southern Kuriles). Curiously it is replaced in the neighboring island Etorohu-sima by *E. chinensis* Tat-

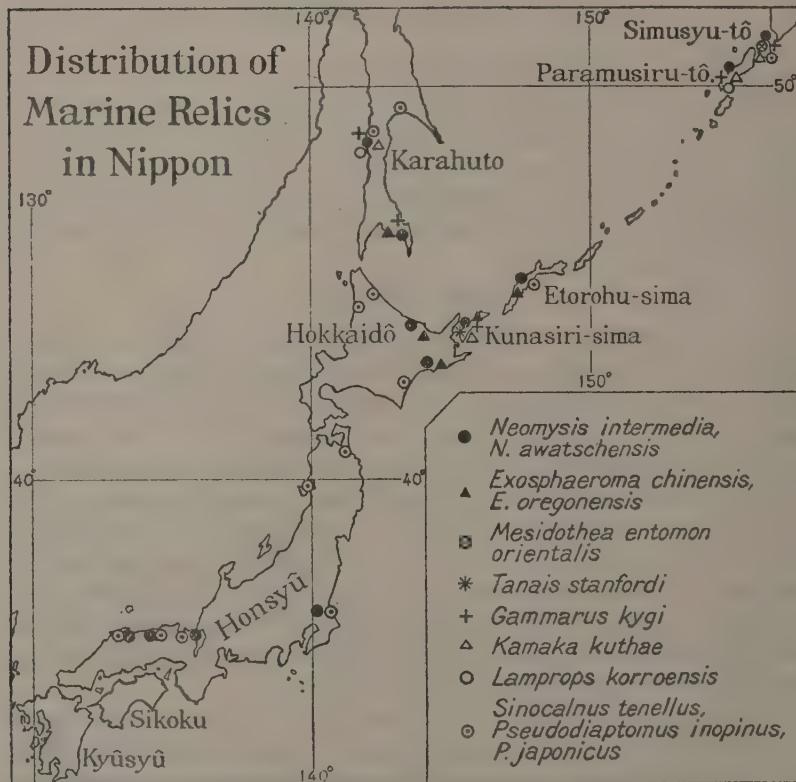


FIG. 1.

tersal, which was first described from brackish water near Shanghai, southern China. The list of localities of these animals may possibly be enriched by further research of relic lakes, especially on the Japan seacoast of Honshu.

Mesidothea entomon orientalis Gurjanowa [Isopoda].—*Mesidothea entomon* and its subspecies are distributed widely near the coast in the circumboreal regions and often appear in fresh

water as marine relics. I have collected this animal in Bettobunuma, Simusyu-to (northern Kuriles). Although this lake is somewhat tidal, the water is not very salty, and contains a chironomid of the *plumosus* group.

Tanaid stanfordi Richardson [Tanaidacea] (text fig. 2).—This interesting animal was collected by the writer in two freshwater lakes, Nikisiro-ko and Tohutu-ko, in Kunasiri-sima (southern Kuriles) and studied by Stephenson (1936). Another locality is a lagoon lake in Clipperton Island (about 10° north latitude and 112° west longitude) in the southern Pacific Ocean. No other species belonging to Tanaidacea is known to occur in fresh water.

Gammarus kygi Dershavin [Amphipoda].—This relic crustacean was found in some lakes in southern Saghalin, and northern and southern Kuriles. In Simusyu-to (northern Kuriles) it is restricted to the relic lakes near the seashore, while the lakes on the plateau are inhabited by *Gammarus pulex*.

Kamaka kuthæ Dershavin [Amphipoda].—An inhabitant of lagoon lakes of Kamchatka, southern Saghalin, and northern Kuriles.

Lamprops korroensis Dershavin [Cymacea].—This animal has the same distribution as *Kamaka kuthæ*. It occurs abundantly on shallow sandy bottoms.

Sinocalanus tenellus (Kikuchi) [Copepoda].—This copepod is found in the plankton in some lakes of southern Saghalin and Etorohu-sima (southern Kuriles). Its distribution is very wide, including Kamchatka, Alaska, Siberia, and China. Besides this species there are other relic copepods, such as *Pseudodiaptomus inopinus* Burkhart (in Kasumiga-ura and Koyama-ike in Honshu, and *P. japonicus* Kikuchi (in Suigetu-ko and Togo-ike in Honshu). The geographical distribution of these animals was well studied by Kikuchi.(4)

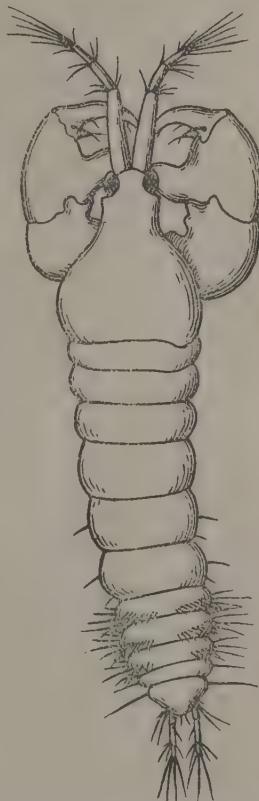


FIG. 2. *Tanaid stanfordi* Richardson. (After K. Stephenson.)

Platichthys stellatus (Pallas) and *Kareius bicoloratus Basilewski* [*Pleuronectidæ*].—Although it is somewhat inappropriate to include these flatfishes among marine relics because they are found in the estuaries too, they never appear in fresh-water lakes except in those of marine origin.

LAND-LOCKED ANIMALS

Land-locked animals are those confined in fresh-water habitats and which have lost their traditional habit of communicating between the ocean and the inland waters in the spawning season. While most marine relics are crustaceans, all land-locked animals are fishes. Although there are two sorts of such migratory fishes, anadromous and katadromous, only the former have land-locked species among them. It is well known that salmonoid and certain other fishes ascend the rivers to spawn. In some species, however, the young fish loses the habit to go back to the sea and remains in the stream for life. With regard to the origin of anadromous habits, Johnstone suggests that salmons were originally marine fishes, and that they have developed the habit of spawning in fresh water in order to protect their eggs from marine enemies.⁽¹⁷⁾ The following fishes are known as land-locked animals in Nippon.

Oncorhynchus masou Brevoort [*Salmonidæ*].—This fish is found in northern Honshu and Hokkaido. In Hokkaido it is land-locked imperfectly, in that all females and some of the males go downstream with the first spring flood of melting ice after the hatch, while the rest of the males remain in the stream where they reach sexual maturity. The males with different habits exhibit different appearances, and the sea-run form is locally called 'Ginke-yamame'.¹ It is remarkable that the same fish is land-locked near the headwaters of the river Daikokei in Taiwan, Formosa, at an altitude of over 1,500 meters, at about 24° 16' north latitude and 121° 18' east longitude.⁽¹³⁾ The water temperature there is about 14.7 to 17.2° C. in July, nearly as low as that of the mountain streams in Honshu. This region is the southern limit for the distribution of Japanese salmons, and here the fish is marooned, because the water temperature of the lower courses of the river and the adjacent seas is too high for it. The discontinuous occurrence of this northern fish in this tropical region may be due to a cold climate in the past, of which the glacial topography on the high mountains of Taiwan supplies

¹ Silvery char.

ample evidence. Moreover, the infestation of Formosan *O. masou* by a nematode, *Cystidicola salvelini* (Fujita), which has been known as a parasite of some salmonoid fishes in Hokkaido and Honshu⁽²⁴⁾ may be an indication of the past history of this fish.

Oncorhynchus rhodurus Jordan and McGregor [Salmonidæ].—This fish is found land-locked in the mountain streams of southern Honshu and Kyusyu, and is distinguished from *O. masou* by pink spots on the body surface. In this species too, the adults are often caught in the sea.

Oncorhynchus nerka (Walbaum) [Salmonidæ].—The red salmon, *O. nerka*, in the northern Pacific, has a habit of ascending the river with a lake in its course, and the young fish stays some years in the lake before entering the sea. Two land-locked forms of this fish are known in Nippon, one in Akan-ko in Hokkaido and the other in Tazawa-ko in northern Honshu. The former race has been successfully transplanted into various lakes both in Hokkaido and the mountain regions of Honshu, and is often confused with *O. adonis* Jordan and McGregor. The latter is dusky in color, very slimy, and its name is a synonym of *O. kawamuræ* Jordan and McGregor.

Salvelinus pluvius Hilgendorf [Salmonidæ].—This fish is found in the headwaters of the rivers in Honshu, and exhibits considerable differences in coloration and form from the marine *Salvelinus*. In Sikaribetu-ko in Hokkaido, where the communication of marine fishes is made impossible by a cascade, is found another land-locked form, *S. miyabei* Oshima, which is more closely related to *S. malma* (Walbaum) in the northern seas.⁽¹⁵⁾

Plecoglossus altivelis Temminck and Schlegel [Plecoglossidæ].—This fish was formerly placed in the family Salmonidæ, and has a restricted distribution in the Far East. It ascends the clear rivers in spring and descends to the lower course to spawn in autumn of the same year. The young fish enters the sea and lives as a translucent fry near the coast. Very few fishes survive their first spawning, which takes place within a year after the hatch.

A dwarf land-locked race of this fish is found in Biwa-ko in central Honshu and Ikeda-ko in southern Kyushu. Its origin in the former lake is quite recent, dating from the construction of an artificial dam across the effluent in 1901–1904. It is successfully transplanted into several lakes which it cannot reach in nature, and when the young fish is transferred into rivers it attains nearly the same size as the anadromous one.

Hypomesus olidus Pallas [Osmeridæ].—This fish is found land-locked in some relic lakes, as Kasumiga-ura and Kita-ura in Honshu. Although it propagates very well in many mountain lakes which it can never reach in nature, it becomes smaller year by year in the new habitats.

Salangichthys microdon [Salangidæ].—This ice fish ascends the river for a short distance in spring to spawn. A land-locked type of it is found in Kasumiga-ura. It is very small, about 6 cm long instead of 12, like the anadromous fish, and has a roundish body.

This and the foregoing species never appear land-locked in fresh-water lakes except in those of lagoon origin, and they may also be called marine relics in a wide sense.

Gasterosteus aculeatus aculeatus (Linnæus) and *G. aculeatus microcephalus* (Girard) [Gasterosteidæ].—*G. a. aculeatus* is distributed in northern Nippon as far as Kyushu,(1) where we recognize marine and land-locked types of this subspecies.(23) *G. a. microcephalus* is a land-locked form found in the Kurile Islands and central Honshu. Its morphological characteristics are given below.

Lampetra planeri (Bloch) [Petromyzonidæ].—In Nippon there are two species of lampreys,(12) the sea-run type *L. fluviatilis* (Linnæus) and the land-locked *L. planeri*. While the former is restricted to northern Nippon, the latter is found in southern Honshu and in Kyushu.

Although there are many other anadromous fishes in Nippon, no land-locked form is known of such common fishes as *Oncorhynchus keta* (Walbaum), *O. gorbuscha* (Walbaum) and *Leucosarion petersi* Hilgendorf (Gobiidæ).

MORPHOLOGICAL AND ECOLOGICAL FEATURES

Animals of marine origin are well known to exhibit morphological, physiological, as well as ecological changes in fresh-water habitats. In general, marine animals become dwarfs in fresh water, especially when the habitat is small, this tendency often being regarded as an effect of overpopulation. The land-locked *Plecoglossus altivelis* in Biwa-ko is about one-third as long as the anadromous fish, but it resumes its original dimensions in a suitable habitat. The land-locked red salmon which was transplanted from Akan-ko in Hokkaido to Towada-ko in northern Honshu within a few years attained about one-third the length and one-twentieth the weight of the original stock. The comparative morphological study of marine relics carried

out by Ekman is very incomplete in Nippon. According to K. Ikeda(3) the body length, and dorsal and pectoral spines become shortened in land-locked *Gasterosteus aculeatus aculeatus*, and the larger part of the scuta disappears in *G. a. microcephalus*. These phenomena are interpreted as a sort of neotony, and the isolated races exhibit some characteristic changes in different habitats.

The land-locked and relic animals are usually stenothermal. The glacial marine relics are found in those lakes only which have cold water strata in the depth. The upper temperature limit for the occurrence of *Mysis relicta* is said to be 14° to 16.9° C. The marine relics in European and North American lakes are derived in the glacial period from the fauna of the Arctic Ocean, and cannot endure the high water temperature. The marine relics in Nippon have, on the contrary, no relationship with the glacial period, and some of them are eurythermal in nature. *Neomysis intermedia*, for example, is distributed widely in Kamchatka, northern and southern Kuriles, Saghalin, and Honshu as far as the innermost part of the bay of Kozima-wan in the Inland Sea. In such lakes as Kasumiga-ura, Kita-ura, and Koyama-ike, where *Neomysis* lives and which are all less than 10 meters deep, the summer temperature of the water may rise above 30° C. (Table 1). *Mesidothex entomon orientalis*, *Lamprops korroensis*, and *Kamaka kuthæ* may, on the other hand, be stenothermal, judging from their natural distribution in the northern regions.

TABLE 1.—Physical and chemical characteristics of Koyama-ike in summer (observed by S. Yohimura, July 26, 1929).

Depth. m.	Temperature. °C.	pH.	Oxygen.	
			Mg/l	Per cent.
0	32.1	8.8	8.95	118
2	30.7	8.8	11.13	144
3	27.5	7.6	0	0
5	25.2	7.2	-----	
8	21.2	7.3	0	0

Transparency 0.7 m.

Almost all land-locked animals in Nippon are northern relics or derived from the northern fauna, and stenothermal in nature. *Oncorhynchus masou*, *O. rhodurus*, and *Salvelinus pluvius* live in the headwaters only of the streams. The land-locked forms

of *O. nerka* are caught most numerously in the strata with a temperature of about 12° C., and the land-locked three-spined sticklebacks prefer the cold spring; dyspnea begins at the water temperature of 20° C.

Another characteristic of the glacial marine relics is that they are stenoöxybionts, and are found in those lakes only the deep cold water of which is rich in dissolved oxygen. In fresh water respiration is more difficult than in the ocean(18, 21) and *Mysis relicta* behaves as an euryoxybiont in the sea and a stenoöxybiont in fresh water. In Nippon many relic animals occur in lakes the deep water of which is destitute of dissolved oxygen in summer. This, however, is not sufficient reason to conclude that our marine relics are euryoxybionts, because in such lakes the animals live in shallow water, especially of sandy bottom, due to their greater adaptability to the change of water temperature. While *Mysis* lakes in Europe are usually of the oligotrophic *Tanytarsus* type, *Neomysis* lakes in Nippon belong to the eutrophic *plumosus* type.

In most cases the spawning of marine relics takes place in winter or early spring, as is the case in glacial marine relics.

GEOGRAPHY OF RELIC LAKES

The marine relics in Europe and North America appear in those lakes which were below sea level in the glacial period or just inside of the terminal moraines; the altitudes of these lakes may be over 130 meters above the present sea level, and the distance from the sea several hundred kilometers. In Nippon the highest lake where *Neomysis* appears is situated at an altitude of only 10 meters above the sea; namely, Seseki-numa and Syana-numa in Etorohu-sima; and all relic lakes lie near the coastal region. The deepest *Neomysis* lakes are Toro-numa in Etorohu-sima, 22.5 meters deep, and Tohutu-ko in Kunasirisima, 21.5 meters deep. Our lakes with relic fauna are either drowned valleys dammed up by sand dunes, or lagoons isolated from the ocean by the alluvia, which gradually became fresh, and they are distributed in the regions of land elevations. It is thought easier for marine animals to invade brackish waters in the Tropics than in cooler parts of the earth, because the presence of monocarbonates in the water helps in the elimination of carbon dioxide.(19) Pelseneer(17) also reviewed evidence which indicates that marine animals in tropical regions are at present becoming adjusted to fresh water, especially along the coast of southern Asia, where heavy rains considerably

dilute the ocean. The marine relics and land-locked animals in Nippon are, according to our present knowledge, more numerous in northern than in southern regions (text fig. 1). Many of these animals are of northern origin and need the cold water. The northern sea has a lower salinity than the tropical sea, and is, I think, freshened as effectively by the melting ice as by the rain, if such is a condition for marine inhabitants to become fresh-water animals, and the low temperature makes respiration easier.

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For further literature the reader is referred to Thienemann⁽²¹⁾ and Miyadi.⁽⁶⁾

ILLUSTRATIONS

TEXT FIGURES

- FIG. 1. Distribution of marine relics in Nippon.
2. *Tanaid stanfordi* Richardson. (After K. Stephenson.)

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FRESH-WATER DIATOMS FROM THE ENVIRONS OF
VLADIVOSTOK

By B. W. SKVORTZOW
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ONE PLATE

The first sample of fresh-water diatoms from the environs of Vladivostok was collected by me in the Summer of 1928, when I visited with Prof. V. M. Savich the Botanical Garden of Vladivostok University in the environs of Okeanskaia station, near Amur Bay, in a forest *Hypnum* bog. This bog was about 50 m from the sea shore, about 1 m wide and no more than 20 cm deep. The examination of the present collection gave the following results: (a) The diatom flora of this *Hypnum* bog must be regarded as associated with subaerial diatoms. (b) Forty-two different forms of fresh-water diatoms have been recorded, in addition to several marine species, as *Coscinodiscus radiatus* Ehr., *Grammatophora oceanica* Ehr., *Synedra affinis* Kütz., *Cocconeis scutellum* Ehr. var. *japonica* Skv., and *Melosira* sp. They all have been deposited here by the wind with sea sand. (c) Among fresh-water forms predominate: *Eunotia lunaris*, *Eunotia alpina*, *Eunotia flexuosa*, *Gomphonema acuminatum* var. *coronata*, *Gomphonema angustatum*, *Gomphonema intricatum*, and various small *Pinnularia*. (d) Several interesting forms have been recorded in the collection, as *Melosira roesiana* var. *asiatica*, recently described from North Manchuria; *Eunotia monodon* var. *koreana*, reported as a fossil from South Korea; *Navicula lapidosa*, known from Europe; *Pinnularia Balfouriana* var. *stauroptera*, reported from Nippon and North Manchuria. (e) The following are described here for the first time: *Caloneis lepidula* var. *major* var. nov., *Pinnularia streptoraphe* var. *minor* var. nov., *Pinnularia streptoraphe* var. *interrupta* var. nov., *Cymbella ventricosa* var. *arcuata* var. nov., and *Cymbella turgida* var. *muscosa* var. nov.

All forms found in the above sample are briefly described below. The diagrams have been prepared by me.

MELOSIRA ROESEANA Rabh. Plate 1, fig. 28.

Melosira roesiana Rabh., VAN HEURCK, Synopsis (1880-1885) pl. 89, fig. 5.

Frustule barrel-shaped, with a thick membrane covered with longitudinal rows of small puncta, on side of valve appearing circular, with distinct marginal spines. Valve diameter 0.017 mm; Rows of puncta 8; puncta 18 in 0.01 mm. Infrequent. A subaerial diatom, widely distributed. Reported from North Manchuria.

MELOSIRA ROESEANA Rabh. var. EPIDENDRON Grunow. Plate 1, fig. 34.

Melosira roesiana Rabh. var. *epidendron* Grunow, VAN HEURCK, Synopsis (1881-1885) pl. 89, figs. 17-18.

Frustule more robust, but with coarser striæ. Valve diameter 0.03 mm; striæ 16, puncta 18 in 0.01 mm. Infrequent.

MELOSIRA ROESEANA Rabh. var. ASIATICA Skvortzow. Plate 1, fig. 29.

Melosira roesiana Rabh. var. *asiatica* SKVORTZOW, Subaerial diatom flora from Pin-Chian-Sheng Province, Manchoukuo. Philip. Journ. Sci. 65 (1938) 263-281, pl. 3, figs. 1 and 3.

Differs from the type in its more robust striæ and in the absence of marginal spines. Valve diameter 0.017 mm; striæ 5, puncta 18 to 20 in 0.01 mm. Infrequent. Reported from Manchuria.

TABELLARIA FENESTRATA (Lyngb.) Kützing.

Tabellaria fenestrata (Lyngb.) Kützing, FR. HUSTEDT, Bacillar. (1930) 122-123, fig. 99.

Valve linear, with capitulate ends and undulate middle part. Length, 0.068 mm. Infrequent.

SYNEDRA AMPHICEPHALA Kützing.

Synedra amphicephala Kützing, Fr. HUSTEDT, Bacillar. (1930) 156, fig. 173.

Valve linear-lanceolate, with subcapitate ends. Length, 0.037 mm; breadth, 0.0025. Striæ 15 in 0.01 mm. Infrequent.

EUNOTIA LUNARIS (Ehr.) Grunow.

Eunotia lunaris (Ehr.) Grunow, Fr. HUSTEDT, Bacillar. (1930) 183, 184, fig. 249.

Valve lunate, linear, with broad-rounded ends. Length, 0.053 to 0.0102 mm; breadth 0.0034 to 0.0042. Striæ 15 in 0.01. Common.

EUNOTIA ALPINA (Naeg.) Hustedt.

Eunotia alpina (Naeg.), FR. HUSTEDT, Bacillar. (1930) 185, fig. 252.

Differs from the preceding species in its narrower valve. Length, 0.06 mm; breadth, 0.0017. Striae 15 in 0.01 mm. Infrequent.

EUNOTIA FLEXUOSA Kützing. Plate 1, fig. 6.

Eunotia flexuosa Kützing, FR. HUSTEDT, Bacillar. (1930) 186, fig. 258.

Valve almost linear, with parallel margin and slightly capitate ends. Terminal nodules distinct, each with a long bayonet-shaped fissure in the middle part. Length, 0.12 mm; breadth, 0.003. Striae 12 in 0.01 mm. Not common.

EUNOTIA MONODON Ehr. var. **KOREANA** Skv. Plate 1, fig. 35.

Eunotia monodon Ehr. var. *koreana* SKVORTZOW, Neogene diatoms from the environs of Gensan, Korea (1936) pl. 1, figs. 13, 14, 19, 20, 30, 33.

Valve linear, slightly lunate, dorsal margin moderately curved, ventral slightly concave. End broad and rounded. Length, 0.045 mm; breadth, 0.01. Striae 6 in 0.01 mm. Infrequent. Reported as a fresh-water fossil from South Korea.

EUNOTIA BIGIBBA Kütz. Plate 1, figs. 7 and 16.

Eunotia bigibba Kütz., FR. HUSTEDT, Bacillar. (1930) 175, fig. 214.

Valve lunate, ventral slightly concave, dorsal bi-arcuate, ends obtusely capitate. Length, 0.02 to 0.042 mm; breadth, 0.0085. Striae 11 to 12 in 0.01 mm. Not common.

COCCONEIS PLACENTULA (Ehr.) var. **LINEATA** (Ehr.) Cleve.

Coccconeis placentula (Ehr.) var. *lineata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 262.

Valve elliptical with broad ends. Length, 0.01 mm; breadth, 0.017. Infrequent.

CALONEIS LEPIDULA (Grun.) Cleve var. **MAJOR** var. nov. Plate 1, fig. 4.

Major quam forma typica. Longis valvis 0.056 mm; latis valvis 0.006. Striis 24 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve linear with straight margin and rounded ends. Median line filiform, more robust in the middle with long comma-shaped terminal fissures and distinct central pores. Axial area

linear, somewhat less than $\frac{1}{2}$ of the breadth of the valve, with suborbicular central area. Longitudinal marginal band distinct. Twice longer than the type. Length, 0.056 mm; breadth, 0.006. Striae 24 in 0.01 mm. Infrequent. The type is known from Europe.

STAURONEIS PHOENICENTERON Ehr. fo. **GRACILIS** (Dippel). Plate 1, fig. 36.

Stauroneis phoenicenteron Ehr. var. *gracilis* Cleve, DIPPEL, Diatomeen der Rhein-Mainebene (1905) 82, fig. 174.

Valve narrow-lanceolate with subacute ends. Length, 0.111 mm; breadth, 0.01. Striae radiate, 18 in 0.01 mm. Infrequent.

NAVICULA LAGERHEIMII Cleve var. **INTERMEDIA** Hustedt. Plate 1, figs. 10 and 18.

Navicula Lagerheimii Cleve var. *intermedia* Hustedt, A. SCHMIDT, Atlas Diatom. (1930) pl. 370, fig. 22.

Valve elliptic-lanceolate with broad-rounded ends. Striae radiate and punctate. Isolated puncta distinct. Length, 0.017 to 0.032 mm; breadth, 0.006 to 0.007. Striae 20 to 21 in 0.01 mm. Common. A typical subaerial diatom.

NAVICULA LAPIDOSA Krasske. Plate 1, fig. 31.

Navicula lapidosa Krasske, FR. HUSTEDT, Bacillar. (1930) 272, fig. 444.

Valve rhombical-elliptic with attenuate round ends. Striae very fine, about 25 in 0.01 mm. Length, 0.0153 mm; breadth, 0.0068. Somewhat smaller than the type. Reported from Europe and northern Manchuria.

NAVICULA CONTENTA Grun. fo. **BICEPS** Arnott. Plate 1, fig. 26.

Navicula contenta Grun. fo. *biceps* Arnott, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458c.

Valve linear, slightly constricted in the middle. Ends broad-rounded and subcanitate. Length, 0.011 mm; breadth, 0.002. Striae very fine, indistinct. Common. A subaerial diatom.

NAVICULA CONTENTA Grunow fo. **ELLIPTICA** Krasske. Plate 1, fig. 27.

Navicula contenta Grun. var. *elliptica* Krasske, FR. HUSTEDT, Bacillar. (1930) 278.

Valve elliptical with broad ends. Length, 0.0085 mm; breadth, 0.002. Infrequent.

NAVICULA IGNOTA Krasske. Plate 1, fig. 19.

Navicula ignota Krasske, Beiträge zur Kenntnis der Diatomaceen-flora der Alpen (1932) 116, pl. 1, fig. 19.

Valve linear-triundulate. Length, 0.019 mm; breadth, 0.005. Striae 12 to 13 in 0.01 mm. Infrequent. Reported from North Manchuria and from Shanghai.

NAVICULA REINHARDTII Grunow.

Navicula Reinhardtii Grunow, FR. HUSTEDT, Bacillar. (1930) 301, fig. 519.

Valve elliptic-lanceolate, with very robust lineate costæ. Length, 0.052 mm; breadth, 0.015. Costæ 7 in 0.01 mm. Smaller than the type. Infrequent.

PINNULARIA SUBCAPITATA Greg.? Plate 1, figs. 14, 15, 21.

Pinnularia subcapitata Greg., FR. HUSTEDT, Bacillar. (1930) 317, fig. 571.

Valve linear-lanceolate, with slightly capitulate ends. Central area a broad fascia. Length, 0.034 to 0.035 mm; breadth, 0.0042 to 0.006. Striæ 11 to 14 in 0.01 mm. Common.

PINNULARIA GIBBA Ehr. fo. SUBUNDULATA Mayer. Plate 1, figs. 12 and 13.

Pinnularia gibba Ehr. fo. *subundulata* Mayer, FR. HUSTEDT, Bacillar. (1930) 327, fig. 601.

Valve linear-lanceolate, moderately triundulate, with subcapitate ends. Length, 0.049 to 0.064 mm; breadth, 0.007 to 0.0085. Costæ 9 to 10 in 0.01 mm. Common.

PINNULARIA BREVICOSTATA Cleve.

Pinnularia brevicostata Cleve, FR. HUSTEDT, Bacillar. (1930) 329, fig. 609.

Valve linear, with rounded ends. Axial and central area uniting in a broad-linear space. Length, 0.124 mm; breadth, 0.017. Costæ 7 in 0.01 mm, not interrupted in the middle. Somewhat longer than the type. Median line straight. Common.

PINNULARIA BALFOURIANA Grun. var. STAUROPTERA Skvortzow. Plate 1, fig. 25.

Pinnularia Balfouriana Grun. var. *stauroptera* SKVORTZOW, Diatoms from Kizaki Lake, Nippon (1936) pl. 16, fig. 15.

Valve elliptic-lanceolate, with broad ends. Central area a broad transverse fascia. Length, 0.0187 mm; breadth, 0.005. Costæ 9 to 10 in 0.01 mm. Not common. Reported from Kizaki Lake, Nippon, and from North Manchuria.

PINNULARIA MICROSTAURON (Ehr.) Cleve. Plate 1, fig. 11.

Pinnularia microstauron (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 320, fig. 582.

Valve linear-lanceolate with subrostrate ends. Axial area enlarged and dilated in the middle in a broad transverse fascia. Length, 0.051 mm; breadth, 0.009. Costæ 9 in 0.01 mm. Infrequent.

PINNULARIA STREPTORAPHE Cleve var. **MINOR** var. nov. Plate 1, fig. 3.

Minor quam forma typica et costis latior. Longis valvis 0.081 mm; latis valvis 0.015. Costis 6 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve linear with straight margins and subcuneate, rounded ends. Median line robust and distinctly complex. Central area suborbicular. Costæ moderately convergent at the ends, with distinct longitudinal band. Length, 0.081 mm; breadth, 0.015. Costæ 6 in 0.01 mm. Smaller than the type and more robust striæ. Common.

PINNULARIA STREPTORAPHE Cleve var. **INTERRUPTA** var. nov. Plate 1, figs. 1, 2.

Differ a typo valvis angustis, area centralis uni-biinterruptis. Longis valvis 0.107 ad 0.122 mm; latis valvis 0.017 ad 0.0187. Costis 6 ad 7. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve linear with parallel margins and subcuneate ends. Median line strongly complex. Axial area linear, somewhat less than a third of the breadth of the valve, in the middle uni- or bilaterally interrupted. Striæ slightly divergent in the middle and convergent at the ends. Longitudinal band very strong. Length, 0.107 to 0.122 mm; breadth, 0.017 to 0.0187. Costæ 6 to 7 in 0.01 mm. Common. Differs from the type in narrower valves and interrupted costæ in the middle part.

PINNULARIA GENTILIS (Donk.) Cleve var. **SIBIRICA** Skvortzow. Plate 1, fig. 5.

Pinnularia gentilis (Donk.) Cleve var. *sibirica* SKVORTZOW, Diatoms collected by D. Y. Okada in Nippon pl. 2, fig. 2.

Valve linear, slightly undulate in the middle and rounded ends. Median line strongly complex. Axial area narrow, less than $\frac{1}{3}$ of the breadth of the valve. Costæ moderately divergent in the middle and convergent at the ends, 6½ to 7 in 0.01 mm. Length, 0.17 mm; breadth, 0.022. Differs from var. *sibirica* in its longer and broader valves. Common. Reported from Lake Kenon, near Chita, Transbaikalia, Siberia; and from Central Nippon.

PINNULARIA BOREALIS Ehr. Plate 1, fig. 9.

Pinnularia borealis Ehr., FR. HUSTEDT, Bacillar. (1930) 326, fig. 597.

Valve elliptic, with subtruncate ends. Costæ very robust. Length, 0.03 mm; breadth, 0.009. Costæ 5 in 0.01 mm. Common.

CYMBELLA VENTRICOSA Kützing var. **ARCUATA** var. nov. Plate 1, fig. 20.

Differit a typo valvis ventre directis, raphe leniter arcuatis. Longis valvis 0.024 mm; latis valvis 0.0085. Striis ventralis 12, dorsalis 8 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve semi-elliptic, straight at ventral and arcuate at the dorsal side. Median line arcuate. Axial and central areas indistinct. Length, 0.024 mm; breadth, 0.0085. Striae, ventral 12, dorsal 8 in 0.01 mm. Differs from the type in its straight ventral margin and arcuate median line. Infrequent.

CYMBELLA TURGIDA (Greg.) Cleve. Plate 1, fig. 8.

Cymbella turgida (Greg.) Cleve, FR. HUSTEDT, Bacillar. (1930) 358, fig. 660.

Valve arcuate, ventral side centrally moderately gibbous. Median line almost straight. Length, 0.039 mm; breadth, 0.0085. Striae 6 in 0.01 mm. Common.

CYMBELLA TURGIDA (Greg.) Cleve var. **MUSCOSA** var. nov. Plate 1, fig. 17.

Differit a typo valvis attenuatis cum polis productis et subacutis, ventre leniter undulatis, dorso arcuatis. Longis valvis 0.031 mm; latis valvis 0.007. Striis ventralis 8 ad 9, dorsalis 8 ad 9 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve lunate, with undulate ventral and gibbous dorsal side. Ends attenuate. Axial and central area indistinct. Median line about straight. Length, 0.031 mm; breadth, 0.007. Striae dorsal and ventral 8 to 9 in 0.01 mm. Infrequent. Differs from the type in it elongate and subacute ends.

GOMPHONEMA PARVULUM (Kütz.) Grunow var. **EXILISSIMA** Grun. Plate 1, fig. 20.

Gomphonema parvulum (Kütz.) Grunow var. *exiliissima* Grun., VAN HEURCK, Synopsis (1881-1885) pl. 25, fig. 2.

Valve lanceolate-clavate with the apex broader than the basis. Length, 0.02 mm; breadth, 0.0042. Striae 14 in 0.01 mm. Infrequent.

GOMPHONEMA INTRICATUM Kütz. var. **PUMILA** Grunow. Plate 1, fig. 22.

Gomphonema intricatum Kütz. var. *pumila* Grunow, FR. HUSTEDT, Bacillar. (1930) 375, fig. 699.

Valve linear-clavate. Isolated puncta distinct. Length, 0.023 mm; breadth, 0.0042. Striae 10 to 11 in 0.01 mm. Rare.

GOMPHONEMA ANGUSTATUM (Kütz.) Rabh. Plate 1, fig. 24.

Gomphonema angustatum (Kütz.) Rabh., FR. HUSTEDT, Bacillar. (1930) 373, fig. 690.

Valve lanceolate-clavate, tapering from the middle to both ends. Length, 0.03 mm; breadth, 0.0051. Striae 8 in 0.01 mm. Isolated puncta distinct. Common.

GOMPHONEMA INTRICATUM Kützing. Plate 1, figs. 32 and 33.

Gomphonema intricatum Kützing, FR. HUSTEDT, Bacillar. (1930) 375, fig. 697.

Valve narrow, lanceolate-clavate, with long subacute ends. Length, 0.034 to 0.035 mm; breadth, 0.005. Striae 8 to 10 in 0.01 mm. Common.

GOMPHONEMA ACUMINATUM Ehr. var. CORONATA (Ehr.) W. Smith.

Gomphonema acuminatum Ehr. var. *coronata* (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 370, fig. 684.

Valve subconstricted-clavate, with apiculate apex. Length, 0.057 mm; breadth, 0.012. Striae 12 in 0.01 mm. Very common.

EPITHEMIA ARGUS Kützing.

Epithemia argus Kützing, FR. HUSTEDT, Bacillar. (1930) 383, fig. 727a.

Valve moderately curved with subcapitate ends. Length, 0.054 mm; breadth, 0.009. Striae, 10 in 0.01 mm. Infrequent.

RHOPALODIA GIBBA (Ehr.) O. Müll.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 390, fig. 730.

Valve with straight ventral side and arcuate reflexed dorsal margin. Rare.

HANTZSCHIA AMPHOXYS (Ehr.) Grun. fo. CAPITATA O. Müll.

Hantzschia amphioxys (Ehr.) Grun. fo. *capitata* O. Müll., FR. HUSTEDT, Bacillar. (1930) 394, fig. 748.

Valve linear, moderately curved, with capitate ends. Length, 0.061 mm; breadth, 0.007. Keel puncta 8, striae 20 in 0.01 mm. Infrequent.

HANTZSCHIA AMPHOXYS (Ehr.) Grun. var. VIVAX (Hantz.) Grunow.

Hantzschia amphioxys (Ehr.) Grun. var. *vivax* (Hantz.) Grunow, FR. HUSTEDT, Bacillar. (1930) 394, fig. 750.

Valve linear-lanceolate, moderately curved, with long attenuate ends. Length, 0.125 mm; breadth, 0.01. Keel puncta 5, striae 18 in 0.01 mm. Infrequent.

NITZSCHIA PALEA (Kütz.) W. Smith. Plate 1, fig. 23.

Nitzschia palea (Kütz.) W. Smith, Fr. HUSTEDT, Bacillar. (1930) 416,
fig. 801.

Valve linear-lanceolate, parallel in the middle and attenuate at the ends. Length, 0.022 mm; breadth, 0.0025. Keel puncta 9 in 0.01 mm. Striae indistinct. Common.

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ILLUSTRATIONS

PLATE 1

- FIGS. 1 and 2. *Pinnularia streptoraphe* Cleve var. *interrupta* var. nov.
- FIG. 3. *Pinnularia streptoraphe* Cleve var. *minor* var. nov.
4. *Caloneis lepidula* (Grun.) Cleve var. *major* var. nov.
5. *Pinnularia gentilis* (Donk.) Cleve var. *sibirica* Skv.
6. *Eunotia flexuosa* Kütz.
7. *Eunotia bigibba* Kütz.
8. *Cymbella turgida* (Greg.) Cleve.
9. *Pinnularia borealis* Ehr.
10. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
11. *Pinnularia microstauron* (Ehr.) Cleve.
- FIGS. 12 and 13. *Pinularia gibba* Ehr. fo. *subundulata* Mayer.
- 14 and 15. *Pinnularia subcapitata* Greg?
- FIG. 16. *Eunotia bigibba* Kütz.
17. *Cymbella turgida* (Greg.) Cleve var. *muscosa* var. nov.
18. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
19. *Navicula ignota* Krasske.
20. *Cymbella ventricosa* Kütz. var. *arcuata* var. nov.
21. *Pinnularia subcapitata* Greg?
22. *Gomphonema intricatum* Kütz. var. *pumila* Grun.
23. *Nitzschia palea* (Kütz.) W. Smith.
24. *Gomphonema angustatum* (Kütz.) Rabh.
25. *Pinnularia Balfouriana* Grun. var. *stauroptera* Skv.
26. *Navicula contenta* Grun. fo. *biceps* Arnott.
27. *Navicula contenta* Grun. fo. *elliptica* Krasske.
28. *Melosira roesiana* Rabh.
29. *Melosira roesiana* Rabh. var. *asiatica* Skv.
30. *Gomphonema parvulum* (Kütz.) Grun. var. *exilissima* Grun.
31. *Navicula lapidosa* Krasske.
- FIGS. 32 and 33. *Gomphonema intricatum* Kütz.
- FIG. 34. *Melosira roesiana* Rabh. var. *epidendron* Grun.
35. *Eunotia monodon* Ehr. var. *koreana* Skv.
36. *Stauroneis phoenicenteron* Ehr. fo. *gracilis* (Dippel).

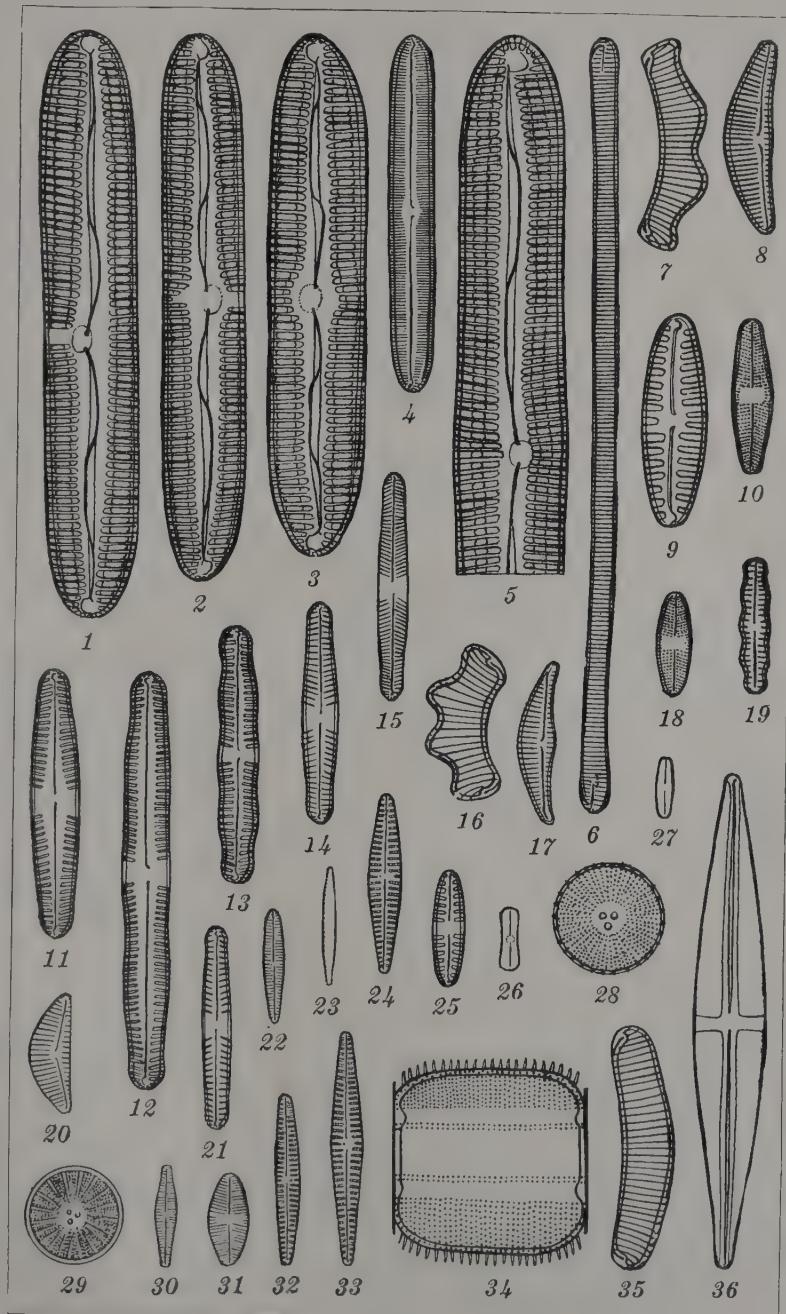


PLATE 1.

SUBAËRIAL DIATOMS FROM PIN-CHIANG-SHENG
PROVINCE, MANCHOUKUO

By B. W. SKVORTZOW
Of Harbin, Manchoukuo

FOUR PLATES

In 1936 I examined several small collections of subaërial diatoms from different parts of Eastern Asia. The material for this investigation consisted of three samples collected by me in Pin-Chiang-Sheng Province, Manchoukuo. Sample 1 was collected in Harbin, September 20, 1927, from the bark of *Ulmus manshurica* Nakai; sample 2 was collected in eastern Harbin, near Maoershan Railway Station, July 20, 1927, on mosses on rocks along a mountain river; sample 3 was collected in eastern Maoershan, near Mifun Station, September 5, 1927, in mosses on mountain rocks. Subaërial diatoms associated with blue-green algae growing in the bark clefts of a Manchurian elm were removed with a hard brush, washed, and the sediment collected and boiled in acids. The mosses from rocks were submerged in water, squeezed by hand, and the greenish brown sediment examined for diatoms.

The examination of the three samples gave the following results: Fifty-nine forms were recognized, 32 per cent of which were new to science and about 90 per cent new to Manchoukuo. The most interesting finds were *Melosira roeseana* var. *indica*, recently reported by me from Calcutta, India; *Stauroneis parvula* var. *rupestris*, found on rocks near Hangchow, Chekiang, China; *Pinnularia Balfouriana* var. *stauroptera*, known from Kizaki Lake, Nippon; *Hantzschia amphioxys* var. *compacta*, reported from Tibet. The forms found in greatest abundance on the bark of a Manchurian elm in Harbin were *Navicula Lagerheimii* var. *intermedia* and *Hantzschia amphioxys*. On the rock mosses of the Maoershan district *Melosira roeseana* var. *epidendron* and var. *asiatica*, *Achnanthes coarctata*, *Navicula Lagerheimii* var. *intermedia*, *Navicula Kotschii* var. *rupestris*, and *Hantzschia amphioxys* var. *compacta*, were the most prevalent. On the mosses from Mifun mountains *Melosira roeseana* var. *asiatica*,

Achnanthes coarctata, *Navicula Lagerheimii* var. *intermedia*, *Navicula Kotschii* var. *rupestrис*, *Navicula contenta* fo. *biceps* and fo. *parallela*, *Pinnularia lata* fo. *thuringiaca*, *Hantzschia amphioxys*, with var. *vivax* and var. *compacta*, were abundant.

Compared on the basis of the present collection, the subaërial diatom flora of North Manchuria has a comparatively large number of species in common with that of Europe, although the floristic composition is different. All fifty-nine subaërial diatoms found in the above samples from North Manchoukuo are described below. The diagrams have been made by me with the aid of Apochromat 2 mm of E. Leitz and Compens-Oculars Nos. 6, 8, and 12. In the following list of algæ the sample number after each species indicates the particular locality from which it was obtained.

MELOSIRA ROESEANA Rabh. Plate 2, fig. 19; Plate 3, figs. 5 and 12; Plate 4, figs. 4 and 22.

Melosira roesiana Rabh. VAN HEURCK, Synopsis (1881-1885) pl. 89, figs. 1-6; A. SCHMIDT, Atlas Diatom. (1893) pl. 176, figs. 7-14; FR. HUSTEDT, Die Kieselalgen (1927) Lief. I, 266, 267, fig. 112a, b.

Frustules in long fasciae, attached to the moss filaments. Valve in zone view cylindrical, with rounded discus rim, covered with spines. Sulkus broad and very distinct. Kollum covered with longitudinal punctate lines. Valve height, 0.017 to 0.034 mm; breadth, 0.01 to 0.012. Striæ 9 in 0.01 mm. Valve in valve view circular, separated into three areas. Marginal area with a marginal rib with fine spines irregularly radiating. Diameter of outer areas about $\frac{1}{3}$ that of valve, composed of radiating rows of beads; inner area a circular hyaline central space with two large beads. Common. Samples 2 and 3.

MELOSIRA ROESEANA Rabh. var. EPIDENDRON Grunow. Plate 3, figs. 4 and 10.

Melosira roesiana Rabh. var. *epidendron* Grunow, VAN HEURCK, Synopsis (1881-1885) pl. 89, figs. 17, 18.

Differs from the type in its coarser structure. Valve height, 0.032 to 0.047 mm; breadth, 0.01 to 0.03. Striæ 14 in 0.01 mm. Radiating rows alternately longer and shorter. Marginal spines distinct. Central space with 1 to 5 isolated beads. Abundant. Sample 2.

MELOSIRA ROESEANA Rabh. var. EPIDENDRON Grun. fo. PODOCYCLIA Grunow. Plate 3, fig. 6.

Melosira roesiana Rabh. var. *epidendron* Grunow fo. *podocyclia* Grunow, VAN HEURCK, Synopsis (1881-1885) pl. 89, figs. 19, 20.

Differs from var. *epidendron* by the presence of large pores around the valve. Valve height 0.03 mm; breadth, 0.024. Striae 14 to 15 in 0.01 mm. Sample 2.

MELOSIRA ROESEANA Rabh. var. **EPIDENDRON** Grun. fo. **SPINOSA** fo. nov. Plate 3, fig. 2.

Valvis formae typicae consimilis, area centralis spinosa. Longis valvis 0.06 mm; latis valvis 0.04 ad 0.051. Striis 15 in 0.01 mm. Habit. in rupestris muscoides prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Differs from var. *epidendron* Grun. by the presence of small spines in the center of the valve. Infrequent. Sample 2.

MELOSIRA ROESEANA Rabh. var. **INDICA** Skvortzow. Plate 4, fig. 5.

Melosira Roeseana Rabh. var. *indica* SKVORTZOW, Diatoms from Calcutta, India (1935) 180, pl. 1, fig. 1.

Differs from the type in broad marginal zone with a diameter of about $\frac{1}{2}$ of the valve with large, robust spines. Diameter of the valve, 0.04 to 0.045 mm. Striae 9 in 0.01 mm. Infrequent. Sample 3. Reported from Calcutta, India.

MELOSIRA ROESEANA Rabh. var. **ASIATICA** var. nov. Plate 3, figs. 1 and 3.

Valvis 0.013 and 0.037 mm metientibus, striis marginalibus radiatibus hyalinis, circiter 0.008 and 0.009 in 0.01 mm, jugis radiatibus punctatis, ad marginem valve 5 ad 6 dispositis. Area centrali hyalina, tribus maculis ornata, maculis valvis infra in intervalla macularum valvi positis. Spinis marginalibus nullo. Habit. in rupestris muscoides prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve view circular, with distinct marginal area without marginal spines. The outer area composed of the extension of the radiating 29 to 31 rows of beads. Each row at the marginal part is composed of 5 to 6 chains of beads, diminishing slightly to the central space. Rows radial, alternately longer and shorter, with distinct interspaces opposite the origin of the latter. Central space hyaline, with three isolate large beads. Valve breadth, 0.013 mm; valve height 0.02 to 0.022. Radiating rows 3 to 5; beads in marginal part 8 to 9; beads on the inner part 18 to 20 in 0.01 mm. Common. Samples 2 and 3. Differs from the type in its radiating beaded area similar to the *Stephanodiscus carconensis* Grun., and in the absence of marginal spines.

FRAGILARIA CAPUCINA Desm. var. **MESOLEPTA** (Rabh.) Grunow.

Fragilaria capucina Desm. var. *mesolepta* (Rabh.) Grunow, FR. HUSTEDT, Bacillar. (1930) 138, fig. 128.

Valve linear, constricted in the middle. Ends subrostrate. Length, 0.0238 mm; breadth, 0.0025. Striae 18 in 0.01 mm. Rare. Sample 2.

SYNEDRA ULNA (Nitzsch) Ehr. var. **AMPHIRHYNCHUS** (Ehr.) Grunow.

Synedra ulna (Nitzsch) Ehr. var. *amphirhynchus* (Ehr.) Grunow, A. SCHMIDT, Atlas Diatom. (1914) pl. 302, figs. 23-26.

Valve narrow linear-lanceolate, with attenuate capitate ends. Length, 0.17 mm; breadth, 5. Striae 8 in 0.01 mm. Filaments only. Rare. Sample 2.

EUNOTIA PRAERUPTA Ehr. Plate 1, figs. 12, 13, and 46.

Eunotia praerupta Ehr., A. SCHMIDT, Atlas Diatom. (1911) pl. 273, figs. 12, 14, 25.

Valve lunate-curvate, with arcuate dorsal side and moderately curvate ventral. Ends subrostrate and broad-round. Terminal nodules distinct. Length, 0.037 to 0.057 mm; breadth, 0.01 to 0.017. Striae 12 to 15 in 0.01 mm. Common. Samples 2 and 3.

EUNOTIA PRAERUPTA Ehr. var. **INFLATA** Grun. fo. **CURTA**. Plate 1, fig. 27.

Eunotia praerupta Ehr. var. *inflata* Grun. fo. *curta* A. SCHMIDT, Atlas Diatom. (1911) pl. 273, fig. 8.

Differs from the type in its broad, inflated ends. Length, 0.022 mm; breadth, 0.0068. Striae 9 in 0.01 mm. Rare. Sample 2.

EUNOTIA MONODON Ehr. var. **MINOR** (W. Smith) Hust. fo. **BIDENS** (W. Smith). Plate 1, figs. 35 to 37.

Eunotia monodon Ehr. var. *major* (W. Smith) Hust. fo. *bidens* (W. Smith), A. SCHMIDT, Atlas Diatom. (1911) pl. 273, figs. 35-38, 40.

Valve slightly lunate or nearly straight. Dorsal arcuate, biundulate. Ends broad-rounded. Ventral side moderately curvate. Length, 0.015 to 0.02 mm; breadth, 0.005. Striae 12 in 0.01 mm. Common. Sample 2.

EUNOTIA BIGIBBA Kützing. Plate 1, fig. 38; Plate 2, fig. 11; Plate 3, figs. 8 and 9.

Eunotia bigibba Kützing, A. SCHMIDT, Atlas Diatom. (1913) pl. 290, figs. 9, 17-19.

Valve moderately curved, with distinct biundulate dorsal margin and slightly concave ventral. Ends broad subcapitate and distinctly abrupt. Length, 0.025 to 0.039 mm; breadth, 0.0085 to 0.01. Striae 10 to 15 in 0.01 mm. Common. Sample 2.

EUNOTIA BIGIBBA Kütz. var. **PUMILA** Grunow. Plate 1, fig. 44.

Eunotia bigibba Kütz. var. *pumila* Grunow, FR. HUSTEDT, Bacillar. (1930) 175, fig. 25.

Smaller than the type. Length, 0.0153 mm; breadth, 0.0068. Striae 15 in 0.01 mm. Shorter striae between longer striae on the margin of dorsal side distinct. Rare.

EUNOTIA BIGIBBA Kütz. var. **RUPESTRIS** var. nov. Plate 1, fig. 39.

Differet a typo crenae dorsali abruptis. Valvis longis 0.064 mm; valvis latis 0.013. Striis 10 in 0.01 mm. Habit. in rupestris muscoides prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Differs from the type in abruptly obtuse dorsal undulations. Length, 0.064 mm; breadth 0.013. Striae 10 in 0.01 mm. Uncommon. Sample 2.

EUNOTIA GRACILIS (Ehr.) Ralfs. Plate 2, fig. 6.

Eunotia gracilis (Ehr.) Ralfs, FR. HUSTEDT, Bacillar. (1930) 185, fig. 253.

Valve linear, lunately curved. Ends capitate. Length, 0.069 mm; breadth, 0.005. Striae 11 in 0.01 mm. Rare. Sample 2.

ACHNANTHES COARCTATA Breb. Plate 1, figs. 1 to 4.

Achnanthes coarctata Breb., VAN HEURCK, Synopsis (1881-1885) pl. 26, figs. 17-20.

Valve lanceolate, constricted in the middle. Ends subrotundate and obtuse. Upper valve with eccentric axial area. Lower valve with an oblique median line and rectangular broad central area. Length, 0.032 to 0.039 mm; breadth, 0.009 to 0.01. Striae 12 in 0.01 mm, with robust puncta. Abundant. Samples 2 and 3. Reported from moist earth and in mosses.

FRUSTULIA VULGARIS Thwaites var. **RUPESTRIS** var. nov. Plate 4, fig. 18.

Differet a typo valvis marginem subplanis. Longis valvis 0.034 mm; latis valvis 0.006. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve narrow-lanceolate with attenuate broad ends. Axial and central areas and striae indistinct. Median line straight. Length, 0.034 mm; breadth, 0.006. Rare. Sample 3.

Differs from the type in its middle undulate part.

DIPLONEIS RUPESTRIS sp. nov. Plate 1, fig. 9.

Valvis ellipticis ad marginem concavis, polis subcuneatis. Raphe distincta directa modice obliquiis. Area axillaris at centralis angusta linearis, area lateralis elliptico-lanceolatis et hyalinis. Striis radiantes, 18 ad 20 in 0.01 mm. Longis valvis 0.015 mm; latis valvis 0.005. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve elliptic, with attenuate acute ends. Median line robust, distinct, and arcuate throughout. Furrows narrow lanceolate, light in color. Central area rectangular and narrow. Striae slightly radiate, distinctly punctate, crossed by a distinct longitudinal band. Length, 0.015 mm; breadth, 0.0051. Striae 18 to 20 in 0.01 mm. Rare. A peculiar species, akin to genus *Diploneis*.

STAURONEIS OBTUSA Lagerst. Plate 3, fig. 11.

Stauroneis obtusa LAGERST., Sotvattens-Diatomaceer fram Spitsbergen och Beeren Eiland (1873) 36, pl. 1, fig. 11.

Valve long-lanceolate with attenuate acute ends. Both ends with transverse round siliceous ribs. Median line filiform with distinct terminal fissures. Axial area narrow-linear, central area a broad rectangular fascia. Striae radiate, punctate, about 16 to 17 in 0.01 mm. Length, 0.072 mm; breadth, 0.012. Rare. Sample 2. Known from Europe, from moist rocks in mountainous districts.

STAURONEIS PARVULA Grun. var. RUPESTRIS Skvortzow. Plate 1, fig. 22.

Stauroneis parvula Grun. var. *rupestris* SKVORTZOW, Subaërial diatoms from Hangchow, Chekiang Province, China, pl. 1, fig. 20.

Valve linear-lanceolate with parallel margins slightly interrupted in the middle and subrostrate ends. Striae slightly radiate, about 30 in 0.01 mm. Length, 0.017 mm; breadth, 0.0034. Infrequent. Sample 2. Reported from moist rocks from environs of Hangchow, China.

STAURONEIS RUPESTRIS sp. nov. Plate 1, fig. 40.

Valvis lanceolatis cum polis subrostratis, obtusis et truncatis. Raphe directa. Area axillaris angusta inconspicuis. Area centralis vitta transversa nuda interruptis. Striis transversis radiantibus, 15 in 0.01 mm. Longis valvis 0.015 mm; latis valvis 0.0042. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear-lanceolate, with broad subrostrate ends. Median line filiform, axial area very narrow. Central area a broad rectangular fascia. Striae distinctly radiate, about 15 in 0.01 mm, not coarser at the ends. Length, 0.015 mm; breadth, 0.0042. Rare. Sample 2. Akin to *Stauroneis montana* Krasske.

NAVICULA LAGERHEIMII Cleve var. **INTERMEDIA** Hust. Plate 1, figs. 14, 31, and 42; Plate 2, fig. 8; Plate 4, figs. 13, 14, 16, 17, 19, 23, and 24.

Navicula Lagerheimii Cleve var. *intermedia* Hustedt, A. SCHMIDT, Atlas Diatom. (1930) pl. 370, fig. 22.

Navicula pseudoseminulum SKVORTZOW, Diatoms recoltees par le Pere E. Licent dans le Nord de la Mandjourie (1935) 40, pl. 9, fig. 27. *Navicula Lagerheimii* Cleve var. *intermedia* Hust., SKVORTZOW, Sub-aërial diatoms from Hangchow, Chekiang, China (1937) pl. 1, fig. 33.

Valve lanceolate with distinct broad margins. Axial area narrow, central area a broad fascia not reaching the margin. Isolated puncta indistinct from one side of fascia. Striae radiate, distinctly punctate, about 18 to 21 in the middle and 22 to 25 at the ends. Common. Samples 1, 2, and 3. Reported by me in 1935 as *Navicula pseudoseminulum* Skv. Only now I have recognized the marginal isolated puncta. Abundant in Harbin, associated with blue-green algae.

NAVICULA LAGERHEIMII Cleve var. **ROBUSTA** var. nov. Plate 4, figs. 8 and 9.

Major quam forma typica et area centralis obscuro. Longis valvis 0.045 mm; latis valvis 0.015. Striis radiantes 20 ad 21 in 0.01 mm. Habit. in rupestris muscosis prope Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve lanceolate-elliptic, with broad-rounded ends and robust siliceous membrane. Median line filiform. Axial area narrow, central a transverse fascia, not reaching the margin. Isolated puncta indistinct. The space between the central pores dark. Striae radiate, 20 to 21 in 0.01 mm crossed by longitudinal blank undulating bands. Differs from var. *intermedia* Hust. in robust large valves and the dark space between the central pores. Sample 3.

NAVICULA LAGERHEIMII Cleve var. **OVATA** Skvortzow. Plate 4, figs. 6, 10, and 20.

Navicula Lagerheimii Cleve var. *ovata* SKVORTZOW, Subaërial diatoms from Shanghai, pl. 1, figs. 5, 6, 24.

Differs from the type in ovate valves with broad obtuse ends. Length, 0.01 to 0.0136 mm; breadth, 0.0051 to 0.0068. Striae

about 20 in 0.01 mm. Common. Samples 1 and 2. Reported from bark of trees in Shanghai.

NAVICULA LAGERHEIMII Cleve var. LANCEOLATA var. nov. Plate 4, figs. 11 and 12.

Valvis ellipticis-lanceolatis cum polis rostratis et obtusis. Longis valvis 0.0255 mm; latis valvis 0.0068. Striis 18 in 0.01 mm. Habit. in truncus arborum prope Harbin et in rupestris muscosis prope Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit. B. W. Skvortzow.

Valve elliptic-lanceolate with subrostrate ends. Length, 0.0255 mm; breadth, 0.0068. Striae 18 in 0.01 mm. Infrequent. Samples 1 and 3.

NAVICULA MUTICA Kützing. Plate 1, fig. 5, 23, and 26; Plate 2, fig. 5.

Navicula mutica Kützing, FR. HUSTEDT, Bacillar. (1930) 274, 275, fig. 453a.

Valve linear with straight median line with central pores and terminal fissures curved in the same directions. Central area a broad transverse fascia, reaching nearly to the margin with distinct isolated puncta. Striae punctate, 15 to 17 in 0.01 mm. Length, 0.0136 to 0.049 mm; breadth, 0.006 to 0.01. Very common. Samples 2 and 3. Differs from *Navicula Lagerheimii* Cleve var. *intermedia* Hust. in its more robust striae and more distinct isolated puncta.

NAVICULA MUTICA Kütz. var. RHOMBICA var. nov. Plate 2, figs. 16 and 17.

Differ a typo valvis rhombicis cum polis productis. Longis valvis 0.034 ad 0.04 mm; latis valvis 0.012 ad 0.014. Striis 15 in 0.01 mm. Poro solitario distinctis. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve rhombical-lanceolate with undulate middle part. Axial area narrow, central a rectangular fascia. Striae distinct, punctate, about 15 in 0.01 mm. Length, 0.034 to 0.04 mm; breadth, 0.012 to 0.014. Rare. Sample 2. Differs from the type in its rhombical shape.

NAVICULA KOTSCHYI Grun. var. RUPESTRIS var. nov. Plate 1, fig. 32; Plate 2, fig. 3.

Differ a typo valvis elongatis, productis, subacutis, striis transversis et robustis. Longis valvis 0.042 ad 0.068 mm; latis valvis 0.014 ad 0.018. Striis 11 ad 15 in 0.01 mm. Habit. in rupestris muscosis prope Maoershan et Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve elliptic-lanceolate with attenuate, subacute ends. Median line straight, with terminal pores curved in the same directions. Central area a rectangular fascia with a distinct isolated

puncta near the central nodules. Striae radiate, punctate, in irregular longitudinal undulating bands. Length, 0.042 to 0.068 mm; breadth, 0.014 to 0.018. Striae 11 to 15 in 0.01 mm. Differs from the type in its elongate valves, attenuate towards the subacute ends. Striae more robust. Differs from *Navicula pseudodemerarae* Hust.¹ in having irregular longitudinal blank undulating bands. Very common. Samples 2 and 3.

NAVICULA OCELLATA sp. nov. Plate 1, fig. 41.

Valvis ellipticis cum polis rotundatis. Raphe directa cum polis terminalibus dilatatis. Area axillaris angusta, medio valvae area centralis suborbicularis cum poro solitario inter nodulis centralis. Structura punctata, punctis in striis 18 ad 20 in 0.01 mm transversalis et longitudinalis radiantes ordinatis. Longis valvis 0.024 mm; latis valvis 0.013. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve broad, elliptic-lanceolate. Median line straight and filiform. Axial area narrow-linear, central broad-suborbicular with isolated puncta between the central nodules. Striae radiate, punctate, in longitudinal blank bands. Length, 0.024 mm; breadth, 0.013. Striae 18 to 20 in 0.01 mm. Differs from *Navicula mutica* Kütz. in the presence of isolated puncta between the central pores.

NAVICULA OCELLATA sp. nov. var. **POLYMORPHA** var. nov. Plate 2, fig. 18.

Diffrer a typo valvis elongatis ellipticis, poro solitario marginalis, area centralis fronte viza robusta suborbicularis, pone-minoribus. Longis valvis 0.034 mm; latis valvis 0.014. Striis 18 in 0.01 mm. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve elliptical with broad ends. Median line straight, axial area narrow, central broad and suborbicular. The central area from one side of the valve is broader and larger than from the other, with an isolated punctum only on one side. Striae radiate, fine, about 18 in 0.01 mm with indistinct longitudinal blank bands. Length, 0.034 mm; breadth, 0.014. Uncommon. Sample 2.

NAVICULA LAPIDOSA Krasske. Plate 1, fig. 48.

Navicula lapidosa Krasske, FR. HUSTEDT, Bacillar. (1930) 272, 273, fig. 444.

Valve rhombic-elliptic, with broad ends. Axial area very narrow, central area a broad stauros, widened and truncate out-

¹ A. Schmidt, Atlas Diatom. (1930) pl. 370, fig. 9.

wards. Striae radiate, not punctate, about 22 in 0.01 mm. Length, 0.015 mm; breadth, 0.009. Rare. Sample 2.

NAVICULA IGNOTA Krasske. Plate 1, fig. 30.

Navicula ignota KRASSKE, Beiträge zur Kenntnis der Diatomaceenflora der Alpen (1932) 116, pl. 1, fig. 19; SKVORTZOW, Subaërial diatoms from Shanghai (1937) pl. 1, fig. 25.

Navicula Licenti SKVORTZOW, Diatoms recoltees par le Pere E. Licent dan le Nord de la Mandjourie (1935) 40, pl. 9, figs. 11, 29.

Valve linear-lanceolate, with triundulate margins. Axial area narrow, central broader. Striae radiate, robust, middle 15, ends 18 to 20 in 0.01 mm, more distinct in the middle. Rare. Sample 2. Known from Europe. Recently reported from Shanghai and Hangchow, China.

NAVICULA CONTENTA Grunow. Plate 1, fig. 17.

Navicula contenta Grunow, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458a.

Valve linear, broad and slightly triundulate, with broad-obtuse ends. Length, 0.01 mm; breadth, 0.0034. Sample 2. A common subaërial diatom. In the Far East reported from Shanghai, and Hangchow, China.

NAVICULA CONTENTA Grun. fo. **PARALLELA** Petersen. Plate 1, fig. 18.

Navicula contenta Grun. fo. *parallela* Petersen, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458b.

Differs from the type in its parallel margins. Common. Samples 2 and 3.

NAVICULA CONTENTA Grun. fo. **BICEPS** Arnott. Plate 1, figs. 10, 11, and 16.

Navicula contenta Grun. fo. *biceps* Arnott, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458c.

Valve linear, constricted in the middle. Ends broad-rounded. Length, 0.0085 to 0.012 mm; breadth, 0.0025. Striae indistinct. Abundant. Samples 2 and 3. Reported from Shanghai.

NAVICULA CONTENTA Grun. fo. **ELLIPTICA** Krasske. Plate 1, fig. 25.

Navicula contenta Grun. fo. *elliptica* Krasske, FR. HUSTEDT, Bacillar. (1930) 278.

Valve elliptic, with attenuate broad-rounded ends. Length, 0.0136 mm; breadth, 0.0034. Common. Sample 2.

NAVICULA PERPUSILLA Grunow. Plate 1, fig. 21.

Navicula perpusilla Grunow, FR. HUSTEDT, Bacillar. (1930) 278, fig. 459.

Valve broad-elliptic, with enlarged middle part and broad-obtuse ends. Axial and central area broad-elliptic, about $\frac{1}{2}$ of the valve diameter. Striae very fine, radiate, about 35 in 0.01 mm. Length, 0.01 mm; breadth, 0.005. Common. Samples 2 and 3.

NAVICULA CONFERVACEA Kützing. Plate 1, fig. 20.

Navicula confervacea Kützing, FR. HUSTEDT, Bacillar. (1930) 278, fig. 460.

Valve elliptic-lanceolate, with narrow ends. Axial and central areas broad-lanceolate. Striae marginal, radiate, 15 in 0.01 mm. Length, 0.012 mm; breadth, 0.0053. Not common. Sample 2. Smaller than the type.

NAVICULA GIBBULA Cleve. Plate 1, fig. 24.

Navicula gibbula Cleve, FR. HUSTEDT, Bacillar. (1930) 285, fig. 477.

Valve linear-elliptic, with slightly attenuate and broad-rounded ends. Median line filiform, robust, with short and indistinct terminal fissures and distinct central pores curved to one direction up to the margin of the central area. Striae radiate, punctate, in the middle 12 to 15, at the ends 18 to 25 in 0.01 mm. Length, 0.02 to 0.0289 mm; breadth, 0.005 to 0.0068. Rare. Sample 2.

PINNULARIA CONVERGENS sp. nov. Plate 1, figs. 28 and 33.

Valvis linear-lanceolatis cum polis subacutis. Raphe directis, raphe poris medianis approximatis, poris terminalibus sigmoides. Area axillaris sat dilatata, centralis transverse dilatata. Striae convergentibus, nec radiantibus 15 ad 18 in 0.01 mm. Longis valvis 0.0175 ad 0.02 mm; latis valvis 0.0034. Habit. in rupes muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear-lanceolate, attenuate towards the ends. Median line filiform, with bayonet-shaped terminal fissures and slightly curved central pores. Axial area dilated to a broad and long central area, forming a fascia. Striae radiate, about 15 to 18 in 0.01 mm, not coarser at the ends, convergent. Length, 0.0175 mm; breadth, 0.0034. Differs from *Pinnularia leptosoma* Grun. in its convergent and not divergent striae. Rare. Sample 2.

PINNULARIA FASCIATA Lagerst. Plate 1, fig. 29.

Pinnularia fasciata (Lagerst.) FR. HUSTEDT, Bacillar. (1930) 316, fig. 569.

Valve linear-lanceolate, with attenuate and rounded ends. Axial area narrow, broader near the central area. Central area a rectangular fascia. Central pores with linear markings on both sides. Striae slightly radiate, about 24 in 0.01 mm. Length, 0.0187 mm; breadth, 0.0034. Rare. Sample 2.

PINNULARIA LATA (Breb.) W. Smith fo. **THURINGIACA** (Rabh.) A. Mayer. Plate 1, fig. 45; Plate 2, figs. 4, 9, and 10.

Pinnularia lata (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer, Fr. Hustedt, Bacillar. (1930) 326, fig. 596.

Valve elliptic, with slightly truncate-rounded ends. Median line robust, with large comma-shaped terminal fissures and distinct robust central curved nodules. Axial area narrow, central area broad-suborbicular. Costae robust, radiate, divergent in the middle and moderately convergent at the ends, 3 to 4 in 0.01 mm. Length, 0.047 to 0.069 mm; breadth, 0.012 to 0.02. Common in sample 2, rare in sample 3.

PINNULARIA BOREALIS Ehr. Plate 1, figs. 6 and 7.

Pinnularia borealis Ehr., Fr. Hustedt, Bacillar. (1930) 326, fig. 597.

Valve linear-lanceolate, with obtuse or rostrate ends. Median line filiform, with comma-shaped terminal fissures. Axial and central area linear-lanceolate. Costae robust, slightly radiate, about 4 to 5 in 0.01 mm. Length, 0.025 to 0.032 mm; breadth 0.0075 to 0.0085. Common. Samples 2 and 3.

PINNULARIA BOREALIS Ehr. var. **RUPESTRIS** var. nov. Plate 1, figs. 43 and 47.

Differ a typo valvis linearibus ad marginem parallelis. Longis valvis 0.088 ad 0.125 mm; latis valvis 0.012 ad 0.018. Costis 4 ad 5 in 0.01 mm, divergentibus, in media valvarum parte radiantibus, apice convergentibus. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear, with parallel margins and broad-obtuse rounded ends. Median line linear, with large comma-shaped terminal fissures and distinct, slightly curved, central nodules. Axial area linear, central suborbicular. Costae radiate, divergent in the middle and convergent at the ends, 4 to 5 in 0.01 mm. Length, 0.088 to 0.125 mm; breadth, 0.012 to 0.018. Differs from the type in its narrow linear valves with parallel margins. Infrequent. Sample 2.

PINNULARIA BALFOURIANA Grunow. Plate 1, fig. 15.

Pinnularia Balfouriana Grunow, Fr. Hustedt, Bacillar. (1930) 326, fig. 599.

Valve linear-elliptic, with broad-rounded ends. Axial and central areas narrow-lanceolate. Costæ slightly radiate, 11 in 0.01 mm. Length, 0.0136 mm; breadth, 0.004. Infrequent. Sample 2.

PINNULARIA BALFOURIANA Grunow var. **STAUROPTERA** Skv. Plate 1, fig. 8.

Pinnularia Balfouriana Grunow var. *stauroptera* SKVORTZOW, Diatoms from Kizaki Lake, Nippon (1936) pl. 16, fig. 15.

Valve linear with broad-rounded ends. Length, 0.018 mm; breadth, 0.005. Costæ 9 in 0.01 mm. Infrequent. Sample 2. Reported from Nippon.

PINNULARIA ACROSPHAERIA Breb. Plate 2, fig. 7.

Pinnularia acrosphaeria Breb., A. SCHMIDT, Atlas Diatom. (1876) pl. 48, fig. 16.

Valve long-linear, with broad-capitate ends, and more or less gibbous in the middle. Median line filiform, with large comma-shaped terminal fissures and distinct central pores. Axial area broad linear, fine-punctate. Striæ radiate, 10 to 11 in 0.01 mm. Length, 0.093 mm; breadth, 0.01. Differs from the type in its broad-rounded ends. Rare. Sample 2.

PINNULARIA MAIOR (Kütz.) Cleve var. **LINEARIS** Cleve.

Pinnularia maior (Kütz.) Cleve var. *linearis* Cleve, PANTOCSEK, Fossile Bacillar. Ungarns (1903) 111, pl. 7, fig. 113.

Valve linear and not gibbous in the middle. Length, 0.17 mm; breadth, 0.02. Costæ 6 to 6½ in 0.01 mm. Rare. Sample 2.

PINNULARIA AESTUARII Cleve var. **RUPESTRIS** var. nov. Plate 4, fig. 7.

Minor quam forma typica et area centralis unilateralis. Longis valvis 0.064 mm; latis valvis 0.012. Costis 6 in 0.01 mm. Habit. in rupestris muscosis prope Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear, with parallel margins and rounded ends. Axial area narrow, central unilateral interrupted. Longitudinal bands indistinct. Length, 0.064 mm; breadth, 0.012. Costæ 6 in 0.01 mm. Differs from the type in its small size and in having a stauros only on one side of the valve. Sample 3.

EPITHEMIA ARGUS Kützing. Plate 1, fig. 34.

Epithemia argus Kützing, FR. HUSTEDT, Bacillar. (1930) 384, fig. 727c, d.

Valve arcuate and recurved. Length, 0.051 mm; breadth, 0.0085. Costæ 2, striæ 10 in 0.01 mm. Rare. Sample 2.

EPITHEMIA TURGIDA (Ehr.) Kützing. Plate 4, fig. 2.

Epithemia turgida (Ehr.) Kützing, FR. HUSTEDT, Bacillar. (1930) 387, fig. 733.

Valve semielliptic, with rostrate ends. Ventral margin constricted and slightly concave, dorsal margin arcuate. Length, 0.115 mm; breadth, 0.015. Costæ 3 to 4; striæ 9 in 0.01 mm. Infrequent. Sample 3.

EPITHEMIA ZEBRA (Ehr.) Kützing. Plate 4, fig. 21.

Epithemia zebra (Ehr.) Kützing, FR. HUSTEDT, Bacillar. (1930) 384, 385, fig. 729.

Valve semielliptic, with attenuate-rounded ends. Length, 0.059 mm; breadth, 0.01. Costæ 3, striæ 15 in 0.01 mm. Sample 3.

RHOPALODIA GIBBA (Ehr.) O. Müll.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 390, fig. 740.

Valve semilanceolate, with reflexed end and centrally arcuate dorsal side. Length, 0.056 mm; breadth, 0.022. Sample 3.

HANTZSCHIA AMPHIOXYS (Ehr.) Grunow. Plate 2, figs. 12 and 13; Plate 4, fig. 15.

Hantzschia amphioxys (Ehr.) Grunow, A. SCHMIDT, Atlas Diatom. (1921) pl. 329, figs. 11, 12.

Valve linear-lanceolate, concave from ventral and convex from dorsal sides. Ends rostrate. Length, 0.0221 to 0.085 mm; breadth, 0.005 to 0.012. Keel puncta 5 to 9; striæ 18 to 20 in 0.01 mm. Common. Samples 1, 2, and 3. The largest forms, seen only in Harbin, are closely related to var. *maior* Grun.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. **VIVAX** (Hantz.) Grunow. Plate 2, fig. 2.

Hantzschia amphioxys (Ehr.) Grun. var. *vivax* (Hantz.) Grunow, FR. HUSTEDT, Bacillar. (1930) 394, fig. 750.

Differs from the type in its elongate valves with attenuate subacute ends. Length, 0.17 mm; breadth, 0.01. Keel puncta 3 to 5; striæ 15 in 0.01 mm. Very common. Sample 2.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. **COMPACTA** Hustedt. Plate 2, fig. 1; Plate 4, fig. 3.

Hantzschia amphioxys (Ehr.) Grun. var. *compacta* HUSTEDT, Bacillar. aus Innerasien (1922) 145, pl. 10, fig. 42.

Two forms have been observed. One with the valve more robust than in the type, with short subrostrate ends. Length, 0.122 mm; breadth, 0.015. Keel puncta 4; striæ 13 in 0.01 mm. (Plate 2, fig. 1).

One with the valve longer than in the type, with elongate ends. Length, 0.144 mm; breadth, 0.014. Keel puncta 4, striæ 11 to 12 in 0.01 mm (Plate 4, fig. 3). Common. Samples 2 and 3. This variety was reported from Tibet.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. *XEROPHILA* Grunow. Plate 2, fig. 14.

Hantzschia amphioxys (Ehr.) Grun. var. *xerophila* GRUNOW, Diatomeen von Franz Josefs Land (1884) 47.

Differs from the type only in its coarser striæ. Length, 0.018 mm; breadth, 0.004. Keel puncta 8, striæ 25 in 0.01 mm. Infrequent. Sample 2.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. *RUPESTRIS* Grunow. Plate 4, fig. 1.

Hantzschia amphioxys (Ehr.) Grun. var. *rupestris* Grunow, VAN HEURCK, Synopsis (1881-1885) pl. 56, figs. 9, 10.

Differs from the type in its elongate ends. Length, 0.098 to 0.122 mm; breadth, 0.01. Keel puncta 3 to 5; striæ 12 to 16 in 0.01 mm. Sample 3.

NITZSCHIA TRYBLIONELLA Hantzsch. var. *DEBILIS* (Arnott) A. Mayer. Plate 1, fig. 19; Plate 2, fig. 15.

Nitzschia tryblionella Hantzsch var. *debilis* (Arnott) A. Mayer, FR. HUSTEDT, Bacillar. (1930) 400, fig. 759.

Valve elliptic, with short obtuse subacute ends. Length, 0.02 mm; breadth, 0.0085 to 0.01. Costæ 12 to 15 in 0.01 mm. Common. Sample 2. It was unexpected to see this diatom in mosses on rocks.

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LAGERSTEDT, N. G. W. Sotvattens-Diatomaceen fram Spitsbergen och Beerens Eiland. Stockholm (1873).

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VAN HEURCK, H. Synopsis des Diatomees Belges. Anvers (1881-1885).

ILLUSTRATIONS

PLATE 1

- FIGS. 1 and 2. *Achnanthes coarctata* Breb.
FIG. 3. *Achnanthes coarctata* Breb. (schematic).
4. *Achnanthes coarctata* Breb.
5. *Navicula mutica* Kütz.
FIGS. 6 and 7. *Pinnularia borealis* Ehr.
FIG. 8. *Pinnularia Balfouriana* Grun. var. *stauroptera* Skv.
9. *Diploneis rupestris* sp. nov.
FIGS. 10 and 11. *Navicula contenta* Grun. fo. *biceps* Arnott.
12 and 13. *Eunotia praerupta* Ehr.
FIG. 14. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
15. *Pinnularia Balfouriana* Grun.
16. *Navicula contenta* Grun. fo. *biceps* Arnott.
17. *Navicula contenta* Grun.
18. *Navicula contenta* Grun. fo. *parallela* Petersen.
19. *Nitzschia tryblionella* Hantzsch var. *debilis* (Arnott) A. Mayer.
20. *Navicula confervacea* Kütz.
21. *Navicula perpusilla* Grun.
22. *Stauroneis parvula* Grun. var. *rupestris* Skv.
23. *Navicula mutica* Kütz.
24. *Navicula gibbula* Cleve.
25. *Navicula contenta* Grun. fo. *elliptica* Krasske.
26. *Navicula mutica* Kütz.
27. *Eunotia praerupta* Ehr. var. *inflata* Grun. fo. *curta*.
28. *Pinnularia convergens* sp. nov.
29. *Pinnularia fasciata* (Lagerst.)
30. *Navicula ignota* Krasske.
31. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
32. *Navicula Kotschyi* Grun. var. *rupestris* var. nov.
33. *Pinnularia convergens* sp. nov.
34. *Epithemia argus* Kütz.
FIGS. 35 to 37. *Eunotia monodon* Ehr. var. *minor* (W. Smith) Hust. fo. *bidens* (W. Smith).
FIG. 38. *Eunotia bigibba* Kütz.
39. *Eunotia bigibba* Kütz. var. *rupestris* var. nov.
40. *Stauroneis rupestris* sp. nov.
41. *Navicula ocellata* sp. nov.
42. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
43. *Pinnularia borealis* Ehr. var. *rupestris* var. nov.
44. *Eunotia bigiba* Kütz. var. *pumila* Grun.?
45. *Pinnularia lata* (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer.

- FIG. 46. *Eunotia praerupta* Ehr.
 47. *Pinnularia borealis* Ehr. var. *rupestris* var. nov.
 48. *Navicula lapidosa* Krasske.

PLATE 2

- FIG. 1. *Hantzschia amphioxys* (Ehr.) Grun. var. *compacta* Hust.
 2. *Hantzschia amphioxys* (Ehr.) Grun. var. *vivax* (Hantz.) Grun.
 3. *Navicula Kotschyi* Grun. var. *rupestris* var. nov.
 4. *Pinnularia lata* (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer.
 5. *Navicula mutica* Kütz.
 6. *Eunotia gracilis* (Ehr.) Rabh.
 7. *Pinnularia acrosphaeria* Breb.
 8. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
 FIGS. 9 and 10. *Pinnularia lata* (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer.
 FIG. 11. *Eunotia bigibba* Kütz.
 FIGS. 12 and 13. *Hantzschia amphioxys* (Ehr.) Grun.
 FIG. 14. *Hantzschia amphioxys* (Ehr.) Grun. var. *xerophila* Grun.
 15. *Nitzschia tryblionella* Hantzsch var. *debilis* (Arnott) A. Mayer.
 FIGS. 16 and 17. *Navicula mutica* Kütz. var. *rhombica* var. nov.
 FIG. 18. *Navicula ocellata* sp. nov. var. *polymorpha* var. nov. The same valve from both sides.
 19. *Melosira roesiana* Rabh.

PLATE 3

- FIG. 1. *Melosira roesiana* Rabh. var. *asiatica* var. nov.
 2. *Melosira roesiana* Rabh. var. *epidendron* Grun. fo. *spinosa* fo. nov.
 3. *Melosira roesiana* Rabh. var. *asiatica* var. nov.; schematic.
 4. *Melosira roesiana* Rabh. var. *epidendron* Grun.
 5. *Melosira roesiana* Rabh.
 6. *Melosira roesiana* Rabh. var. *epidendron* Grun. fo. *podocyclia* Grun.
 7. *Pinnularia aestuarii* Cleve var. *rupestris* var. nov.
 FIGS. 8 and 9. *Eunotia bigibba* Kütz.
 FIG. 10. *Melosira roesiana* Rabh. var. *epidendron* Grun.
 11. *Stauroneis obtusa* Lagerst.
 12. *Melosira roesiana* Rabh.

PLATE 4

- FIG. 1. *Hantzschia amphioxys* (Ehr.) Grun. var. *rupestris* Grun.
 2. *Epithemia turgida* (Ehr.) Kütz.
 3. *Hantzschia amphioxys* (Ehr.) Grun. var. *compacta* Hust.
 4. *Melosira roesiana* Rabh.
 5. *Melosira roesiana* Rabh. var. *indica* Skv.
 6. *Navicula Lagerheimii* Cleve var. *ovata* Skv.
 7. *Pinnularia aestuarii* Cleve var. *rupestris* var. nov.
 FIGS. 8 and 9. *Navicula Lagerheimii* Cleve var. *robusta* var. nov.
 FIG. 10. *Navicula Lagerheimii* Cleve var. *ovata* Skv.
 FIGS. 11 and 12. *Navicula Lagerheimii* Cleve var. *lanceolata* var. nov.
 13 and 14. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.

FIG. 15. *Hantzschia amphioxys* (Ehr). Grun.

FIGS. 16 and 17. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.

FIG. 18. *Frustulia vulgaris* Thw. var. *rupestris* var. nov.

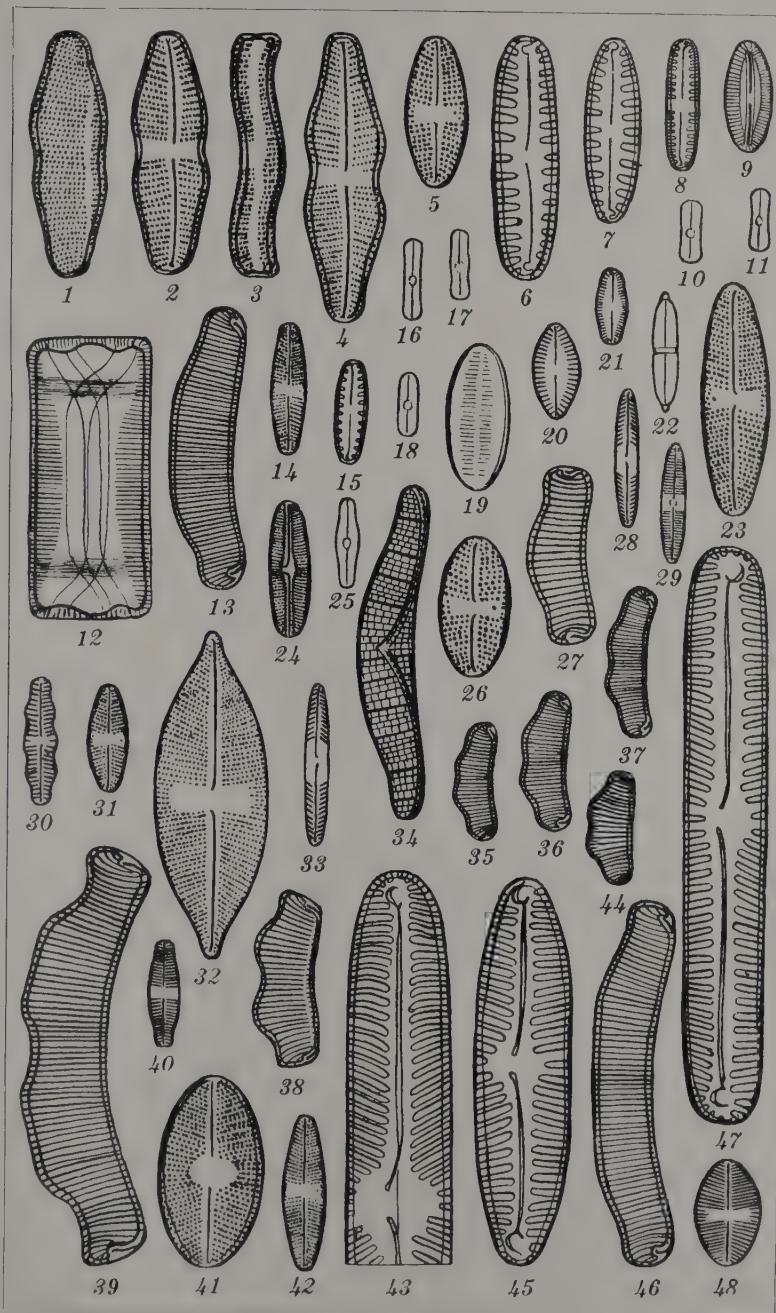
19. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.

20. *Navicula Lagerheimii* Cleve var. *ovata* Skv.

21. *Epithemia zebra* (Ehr.) Kütz.

22. *Melosira roesiana* Rabh.

FIGS. 23 and 24. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.



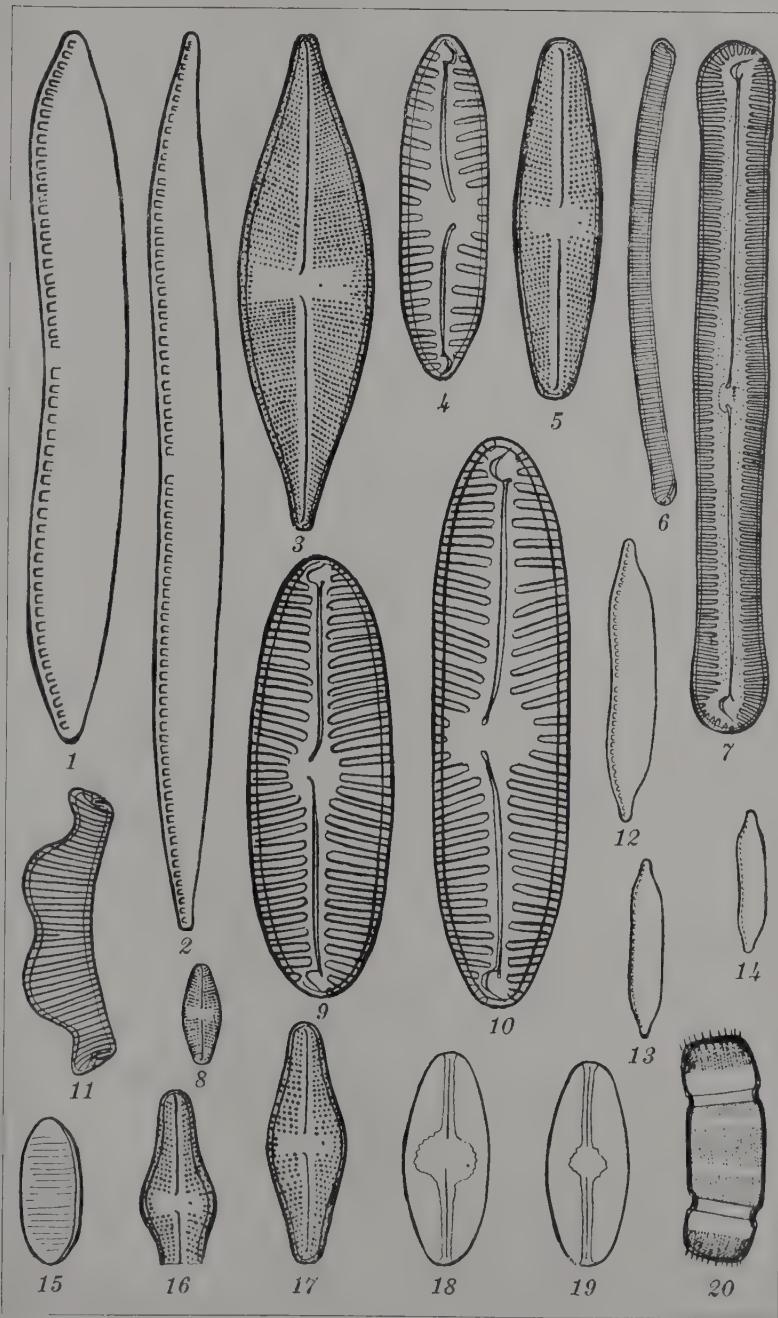


PLATE 2.

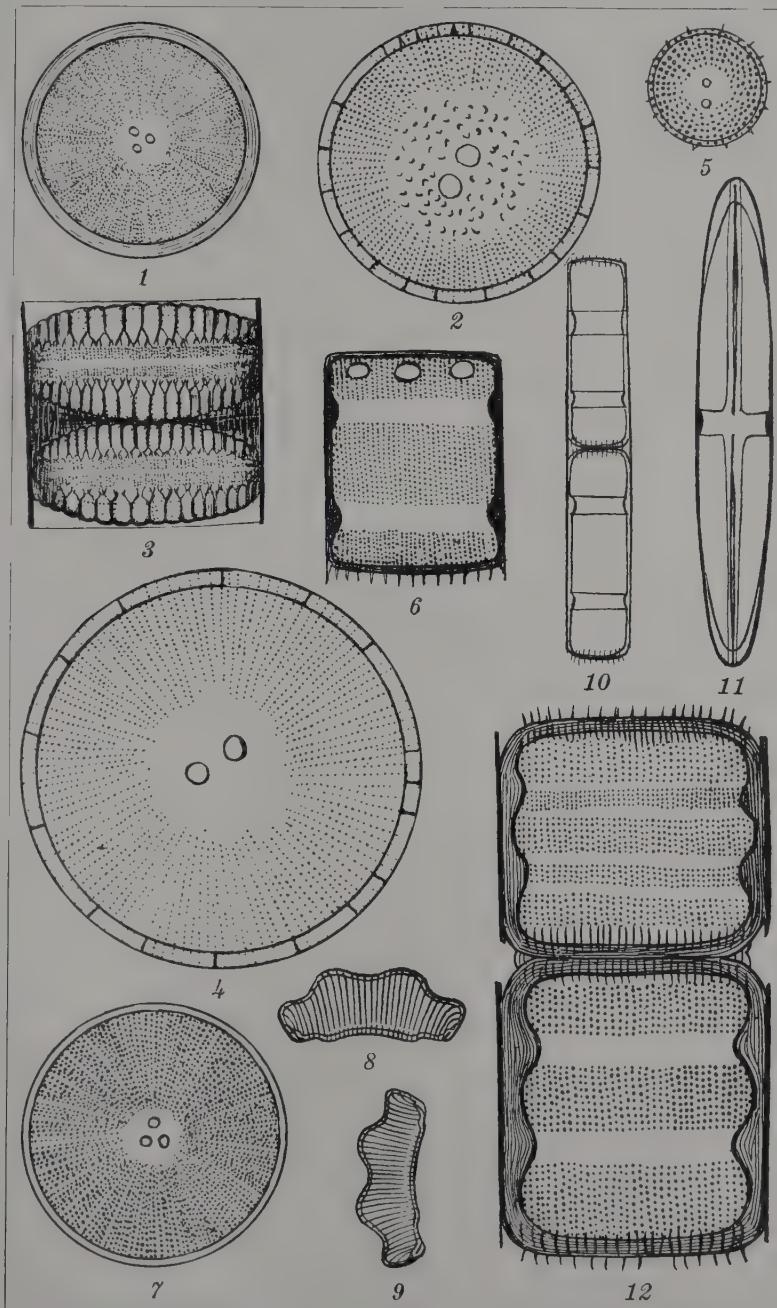


PLATE 3.

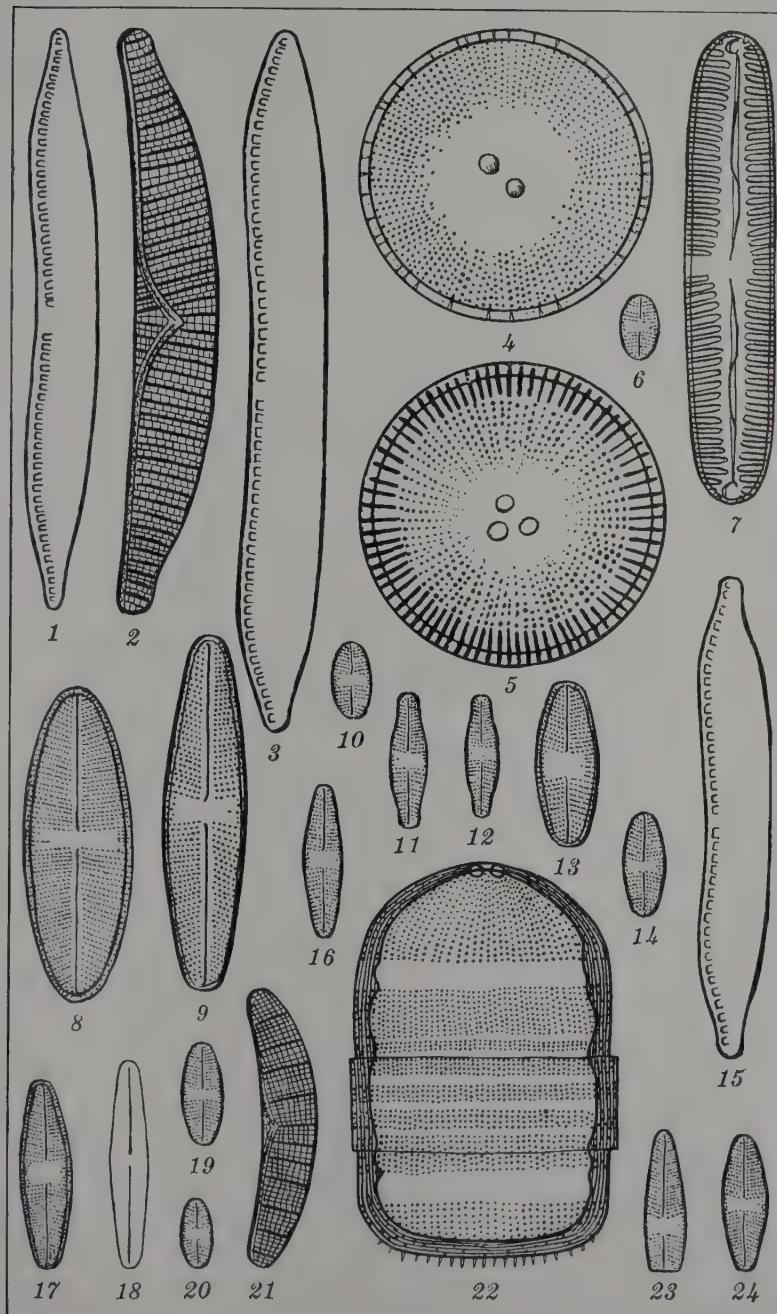


PLATE 4.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

- American Society for Testing Materials. Standards on petroleum products and lubricants. Prepared by Committee D-2. Methods of testing, specifications, definitions, charts, and tables. The Society, 1937. 385 pp., illus. Price, \$2.
- American Society for Testing Materials. Symposium on lubricants, March 8, 1937. The Society, 1937. 89 pp., illus.
- BALK, ROBERT. Structural behavior of igneous rocks (with special reference to interpretations by H. Cloos and collaborators). Memoir 5 of the Geological Society of America, Washington, D. C., 1937. 177 pp., maps, plates, illus.
- BERKOW, SAM GORDON. Childless; a study of sterility, its causes and treatment. New York, Lee Furman, Inc. c1937. 307 pp., illus. Price, \$3.
- BRAGG, WILLIAM. Atomic structure of minerals. Ithaca, Cornell University press, 1937. 292 pp., illus., tables, plates, diagrs. Price, \$3.75.
- CARLSON, ANTON JULIUS, and VICTOR JOHNSON. The machinery of the body. Chicago, University of Chicago press, 1937. 580 pp., illus., tables, diagrs. Price, \$4.
- CURRAN, C. H., and CARL KAUFFELD. Snakes and their ways. New York, Harper & brothers, 1937. 285 pp., illus. Price, \$3.50.
- DAVIS, IRA C., and RICHARD W. SHARPE. Science; a story of progress and discovery. New York, Henry Holt & co., c1936. 491 pp., illus. Price, \$1.72.
- FURTADO, C. X. A commentary on the laws of botanical nomenclature. Gardens' Bulletin, v. 9, pt. 3, Oct. 9, 1937. pp. 223-284.
- FURTADO, C. X. The nomenclature of types. Gardens' Bulletin, v. 9, pt. 3, Oct. 9, 1937. pp. 285-317.
- GENNER, V. By-effects in salvarsan therapy and their prevention; with special reference to the liver function. Copenhagen, Levin & Munksgaard, 1936. 360 pp., tables.
- GORTNER, ROSS AIKEN. Selected topics in colloid chemistry, with special reference to biochemical problems. Ithaca, Cornell University press, 1937. 169 pp., tables. Price, \$2.50.
- HILLIARD, CURTISS M. A textbook of bacteriology and its applications. rev. ed. New York, Ginn & co., c1936. Price, \$3.50.
- IRMINGER, J. O. V., and CHR. NOKKENTVED. Wind-pressure on buildings; experimental researches. Translated from the Danish by Alexander C. Jarvis and O. Brodsgaard. 1st and 2d series. Copenhagen, Danmarks Naturvidenskabelige Samfund, 1930, 1936. 2 vols. Price, 20 kr.

- LINDSEY, ARTHUR WARD. The science of animal life. New York, Harcourt, Brace, and co., c1937. 656 pp., illus. Price, \$3.75.
- LORD, ELIZABETH EVANS. Children handicapped by cerebral palsy; psychological factors in management. With a medical explanation by Bronson Crothers. New York, The Commonwealth fund, 1937. 105 pp. Price, \$1.25.
- MILLIKAN, ROBERT ANDREWS, DUANE ROLLER, and ERNEST CHARLES WATSON. Mechanics, molecular physics, heat, and sound. New York, Ginn and company, c1937. 498 pp. Price, \$4.
- MILLIS, HARRY ALVIN. Sickness and insurance; a study of the sickness problem and health insurance. Chicago, University of Chicago press, c1937. 166 pp. Price, \$2.
- MOULTON, FOREST RAY, ed. The world and man as science sees them. With many linecut and halftone illustrations. Chicago, University of Chicago press, 1937. 533 pp. Price, \$3.
- MURRAY, D. STARK. Science fights death. London, Watts & company, 1936. 149 pp., illus. Price, 2s 6d.
- MUSPER, K. A. F. R. Das erdöl und seine verwandten in den Philippinen. 1937. 17 pp., tables, maps.
- PEACOCK, ALEXANDER H. Globe trotting with a surgeon. With photographs by the author. Seattle, The press of Lowman & Hanford co., 1936. 276 pp.
- WILLIS, BAILEY, and ROBIN WILLIS. Geologic structures. 3d. ed., rev. New York, McGraw-Hill Book co., 1934. 544 pp., illus. Price, \$4.
- WISEMAN, JOHN D. H. Basalts from the Carlsberg Ridge, Indian Ocean, with an appendix on the radium content of some sub-oceanic basalts from the floor of the Indian Ocean, by J. H. J. Poole. (The John Murray expedition, 1933-34, Scientific Reports, v. 3, no. 1, Geological and mineralogical investigations.) London, The British Museum, 1937. 30 pp., plates, illus. Price, 2s 6d.

REVIEWS

Air Conditioning—Insulation; treats of the principles and applications of insulation as used to retard heat losses and gains, and to guard against fire, sound, vibration, condensation, and termites in buildings. By J. Ralph Dalzell and James McKinney. Chicago, American Technical Society, 1937. 301 pp., illus. Price, \$2.50.

This book treats of the principles and applications of insulation as a means of (1) retarding heat losses and gains through structural parts of buildings; (2) preventing loss by fire; (3) controlling sound; (4) preventing vibration; (5) protecting buildings against termites; (6) protecting all mechanical parts against heat losses and freezing; and (7) preventing condensation.

The authors assume that the reader is familiar with simple mathematics, architectural details, design of ducts, and general heating and air-conditioning principles. All principles and

methods of design or calculation are well explained and illustrated.

The book would be useful to students of insulation and to prospective builders of large buildings and hotels.—F. D. M.

Alcoholism in General Practice. By A. E. Carver, Thomas Hunt, and Sir William Willcox. London, Constable & Company, Ltd., 1936. 181 pp. Price, 7s 6d.

The book will find its chief usefulness in the library of the general practitioner, especially the internist, the alienist, and the medico-legal officer.

Because alcoholism is not so common in the Philippines as in temperate climates, local practical application of the information furnished by the authors will naturally be limited. It would, however, be a valuable clinical aid in the determination or verification of certain manifestations of alcoholism; namely, alcoholic neuritis as contrasted with other forms of peripheral neuritis; so-called alcoholic gastritis as differentiated from other gastric and abdominal conditions; and the various effects of alcohol on the renal and circulatory systems, especially the kidneys, the heart, and the blood pressure. It would also be profitable in the determination of whether alcohol has any etiological relationship with our cases of portal cirrhosis.

One very practical application of the book, especially important for medico-legal officers, is the aid it furnishes in the determination of drunkenness.

The book is sufficiently rich in the various suggestions (psychological, medicinal, institutional, and general) for the effective management of alcoholism in various phases.—G. F. A.

The Biological Control of Insects. With a Chapter on Weed Control.
By Harvey L. Sweetman. Foreword by L. O. Howard. Ithaca, Comstock pub. co., inc., 1936. 461 pp., illus. Price, \$3.75.

This is undoubtedly the most comprehensive and most useful book written so far on the biological control of insects. There are 14 chapters, with a foreword of appraisal of the book and its author by Dr. L. O. Howard, former chief of the U. S. Bureau of Entomology, himself one of the leading authorities on biological control. The first chapter deals with the theoretical basis of biological control, among the topics discussed being biotic potential and environmental resistance with special reference to parasites and predators. The whole of chapter 2 is devoted to the use of resistant varieties of plants as a means of controlling

insect pests. In chapters 3, 4, and 5 are described the rôle that bacteria and fungi, viruses, protozoa, and parasitic invertebrate animals (nematelminthes), respectively, play, and the extent to which these may be artificially utilized, in the control of insects. The greater portion of chapters 6, 7, and 8, indeed of the entire book, is chiefly devoted to insect parasites and predators. Chapter 9 deals with some of the biological relations of insect predators and parasites to their hosts.

From a practical standpoint, chapters 10 and 11 are most helpful. Chapter 10 covers the factors that should be considered in the utilization of insect parasites and predators. Chapter 11 deals with the points to be considered before actual introduction may be attempted, the qualities desired in parasites and predators, methods of handling, shipping, rearing, liberation, and other aspects.

Chapter 12 deals with the use of predatory vertebrate animals, such as toads, birds, mammals, and others. Chapter 13 presents the results of biological control, and those that are considered still in the experimental stage are reported and the limitations of biological control discussed. The biological control of pest plants (weeds) is the subject of the last chapter.

The book is provided with a glossary and a long list of references which appears to include the most important works on biological control; the index appears to be complete in every respect. It is apparent that the author has spared no effort to make the book really useful. It is truly authoritative and complete and constitutes a very handy and most valuable guide and reference to all interested in biology. To economic entomologists, in particular, who should be greatly benefited by it, the book is indispensable.—F. Q. O.

Foods; Their Selection and Preparation. By Louise Stanley and Jessie Alice Cline. New York, Ginn and company, c1935. 458 pp., illus. Price, \$2.60.

This book is at its best used as a textbook for beginners' courses in the selection and preparation of food in colleges and teachers' colleges. Although the principles in this book have been the result of experimental work and research, the general aim of the book is to present the subject matter in the way most helpful to the housewife and dietitian.

The book contains twenty-five chapters, supplemented by illustrations in the form of photographs, diagrams, and tables. The first part of the book deals with the composition of food

and the functions of different food nutrients. It gives the physiological and chemical factors responsible for digestion and absorption of foods. Tables showing the total requirements of each food nutrient to meet the needs of different individuals are also given.

The book not only explains how to utilize foodstuffs in their natural form but also describes the chemical phase of how the same foodstuffs and their by-products can be used more profitably.

Different chapters are devoted to fruits, cereals, and vegetables, respectively, giving their classification and composition, supplemented with valuable hints for buying them. Eggs, milk, and milk products are given very interesting and instructive chapters.

Very few recipes are included in this book, which is largely intended to explain the hows and whys of cooking.—C. A.

A Guide to the Mineral Gallery. British Museum of Natural History. 14th ed. 1937. 60 pp., plate, illus. Price, 6d.

In addition to technical and scientific catalogs, the Trustees of the Museum issue short popular guides to the collections in order to assist in the education of the general public which plays such an important part in the work of this as in other great museums. The fourteenth edition of the guide to the minerals is excellently adapted to serve this purpose. It is not so detailed as to be wearisome, and not too inclusive to be complex, but it contains notes on the various collections which include many of the things teachers of mineralogy know so well. Science should be pursued for pleasure and culture as well as for information, and to that end there remains a place for such pamphlets as this modest guide.

Merely reading this guide makes one want to visit the museum, which is probably what it was expected to do, and to wander down the aisles between the cases guide in hand would indeed be pleasant as well as educative.—H. F. B.

High-Speed Diesel Engines. A Practical Text on High-Speed Diesels, Including Instruction on Fuel-Injection and Combustion Systems, Frames and Cylinders, Running Gear, and Construction Details of the Different Models of the Diesel Engines and Their Applications to Industry and Transportation. By L. H. Morrison. Chicago, American Technical Society, 1937. 243 pp., illus. Price, \$2.50.

This is a clearly written and well illustrated practical book. The instructions on the fuel injection and combustion system,

and construction details of different makes of engines, are especially commended. It is a valuable book for anyone interested in the operation of diesel engines.—F. D. M.

Machinery and Equipment of the Cane Sugar Factory. By L. A. Tromp. London, Norman Rodger, 1936. 644 pp., illus. Price, \$8.

This book is an exhaustive textbook on the machinery and equipment used in the sugar factories. It provides comprehensible and valuable information step by step about machinery and equipment from the selection of the sugar factory site to the transportation of the finished product. It combines theory with the practical experience of the author during nearly twenty years of consulting, designing, and operation of cane sugar factories. There are 616 drawings prepared by the author, effectively conveying the technical ideas explained in the text. This book is valuable to engineers designing the machinery as well as those operating them.—F. D. M.

Odyssey of the Islands. By Carl N. Taylor. New York, Charles Scribner's sons, 1936. 284 pp., photographs. Price, \$3.

Carl N. Taylor's *Odyssey of the Islands* makes very interesting and entertaining reading. Unlike other American writers, who came to the Philippines with preconceived ideas for or against independence, Mr. Taylor is unbiased.

The author tells us about his trip to Mindanao, and describes his vivid impressions of primitive life in the Manobo region. He admits that head-hunting, as an institution, still exists among the Manobos; but a Manobo warrior has only one object in chopping off a head—to prove his manhood to the woman he wishes to marry. Head-hunting is also practiced by the Ifugaos of northern Luzon, but to a very limited extent.

There seems to be an established tradition among the Negritos that once a man has ceased to be useful to his tribe he becomes a liability. If food is plentiful, he may be tolerated; if not, he is banished to die in the forest.

In conclusion, the reviewer believes that the book, on the whole, is a fair treatment of the subject. The author has really attempted to give a true picture of native life as he saw it in his wanderings "away from the tourist path." The book would make a valuable reference for any one who desires to know more about the unexplored tribes of the Philippines.—M. J.

An Outline of General Forestry. By Joseph S. Illick. New York, Barnes & Noble, c1935. 259 pp. illus. Price, \$1.50.

This outline is designed primarily as a general introduction to forestry and closely related branches of conservation. It consists of thirty chapters, illustrated with text figures, and provided with questions and references. It thus becomes a very handy and highly desirable reference book for students in forestry, teachers, and forest users.

The book is neither a textbook nor a research contribution. It serves as a guide to a general understanding of what forestry is, how it is developing, where it is heading, and what benefits it is bringing to mankind. It is a valuable addition to private and public libraries, primarily for the youth of the land, upon whom, in the words of Professor Illick, the future of forestry rests.

The outline is eminently fitted for extension and public relations work. In discussing "What Forestry Is," lantern slides, photographs, charts, and maps could be used to advantage. A one-reel motion picture—the A B C of Forestry—is available for distribution through the office of Motion Pictures, U. S. Department of Agriculture. This reel contains excellent pictures and text material to supplement the discussion. A similar procedure could be followed in this country to educate the Filipino youth and the people in the barrios. "The trends in forestry," says the author, "are ever-changing. More and more is the wise forester guiding the whole forestry movement in the direction of sustained yields in health, recreation, work opportunities, and other human benefits."—E. de la C.

Philippine Independence; Motives, Problems, and Prospects. By Grayson L. Kirk. New York, Farrar & Rinehart, Inc., 1936. 278 pp. Price, \$2.50.

In a rather scholarly way, Professor Kirk starts his analysis of the Philippine question from the time when the United States, imbued with the spirit of "Manifest Destiny," decided to retain the Philippines against the desire of the inhabitants to remain independent. He feels that while the persistent Filipino agitation is in principle noteworthy, "it was in reality a demonstration of marked ingratitude which was to be regretted, but which was not to be regarded with any great gravity." Unfortunately, there were groups of economic interests in the United States

which allied with the friends of Philippine independence to undo the American accomplishments in the Islands. The efforts of this unholy alliance, which comprised the old American leaders who were politically rather than economically minded, the Filipino leaders who desired independence at a great price, and these groups of economic interests, brought about the enactment of the Hare-Hawes-Cutting Act and later the Tydings-McDuffie Act. According to the author, the Independence Act was primarily a triumph of selfish interests.

The book is divided into nine chapters: Assuming the white man's burden, the old independence movement, trade follows the flag, the farm groups, the triumph in Congress, the economic outlook, the new Constitution and the political outlook, the Japanese problem, and Filipino-American relations with a suggested program. The appendix includes President Hoover's veto message, the Tydings-McDuffie Act, and the Constitution of the Philippines.—G. P.

Termite City. By Alfred E. Emerson and Eleanor Fish. With a Foreword by William Beebe. Chicago, Rand McNally & Company, c1937. 127 pp., illus. Price, \$1.50.

Although intended for young people, this book is equally instructive to adult readers who will find an admirable description in nontechnical language of the life of termites, with emphasis on natural history. The authors have written a very entertaining account of the social life of termites who live in a community with a government which seems to be more efficient than ours, because every member of their community does his job so well, and members who won't work are eaten up by those who do.—P. S. S.

The Tropical Subsistence Homestead. Diversified Crops in Forest Formation for the Antillean Area. By John C. Gifford. New York, Books, Inc., c1934. 158 pp. Price, \$0.50.

Dedicated to Senator Duncan U. Fletcher because of his long efforts in behalf of national parks, forest conservation, and conservation in general, this little volume contains valuable and highly constructive ideas and forest policies which should be highly interesting to Filipino leaders and students. Professor Gifford has ably discussed the furtherance of the tropical forest subsistence homestead for the Negroes, the Seminoles, and Tropical Indians living in the tradewind area of the American Tropics.

Large proportions of small holdings covered with diversified tree crops in forest formation—a kind of mixed husbandry with the tree in forest formation—is advocated. The subsistence homestead in the opinion of the author is the only permanent and most essential thing that can give life and comfort to the majority of the American people. To him, the best nations of the world are those with the largest number of small, self-supportive, free-of-debt homesites. Sample subsistence homesteads in cities for parks and exhibition purposes are likewise advocated.

The concluding aphorisms bring to light what we should do or not do with regard to the forest of the future. Importance is attached to the profession of forestry and to the forester. In the opinion of Professor Gifford, "a triangle in the future consists of foresters and other producers of raw materials, chemists who convert these products into many other useful products, and the mechanical engineers who can build machines for these purposes."—E. de la C.

